

Prepared for
United States Environmental Protection Agency Region 7
11201 Renner Blvd.
Lexana, Kansas

and

Iowa Department of Natural Resources
Wallace State Office Building
502 East 9th Street, 4th Floor
Des Moines, Iowa

On behalf of
Vogel Paint and Wax Company
109 3rd St NW
Orange City, Iowa

Prepared by
Ramboll US Corporation
Irvine, California

Project Number
1690001847-008

Date
October 7, 2019; Revised January 28, 2020

PILOT STUDY DESIGN PLAN ADDENDUM FOR ENHANCEMENT OF GROUNDWATER REMEDATION

VOGEL PAINT & WAX CO.

**GRANT AVENUE BETWEEN 490TH AND 500TH STREET
MAURICE, IOWA**



PREPARED BY



Eric Smith, PG, CHG
Principal Consultant



David K. Liu, PhD
Principal

P:\V\Verdant Law\0436011H Vogel Paint Maurice IA\Pilot Study\Design Plan\Vogel Paint Maurice Iowa Pilot Design Plan rev 1-28-20.docx

Ramboll
5 Park Place
Suite 500
Irvine, CA 92612
USA
T +1 949 261 5151
F +1 949 261 6202
www.ramboll.com

CONTENTS

	Page
1. INTRODUCTION	1
1.1 Purpose of Pilot Study Design Plan	1
2. BIO-TRAP STUDY - BASIS OF DESIGN	2
2.1 Bio-Trap® Study Design	2
2.2 Bio-Trap® Study Results	3
2.3 Bio-Trap® Study Conclusions – Basis of Design	6
3. MATERIALS AND INJECTION VOLUME AND LAYOUT	7
3.1 EO _x , DAP and PlumeStop®	7
3.2 Former Source Area Injection (EO _x +DAP)	7
3.3 Injection in Downgradient and Off-Site Portion of the Plume (EO _x +DAP)	8
3.3.1 PlumeStop® Barrier	9
4. INJECTION METHODOLOGY	11
4.1 EO _x + DAP	11
4.2 PlumeStop®	11
5. SCHEDULE	12
6. REFERENCES	13

TABLES

Table 1:	Bio-Trap Study Analytical Results
Table 2:	Bio-Trap Study Field Measurements and Water Quality Parameters
Table 3:	EO _x Injection Plan Summary
Table 4:	PlumeStop® Application Design Summary

FIGURES

Figure 1:	Site Location Map
Figure 2:	Ethylbenzene Groundwater Plume 2018 and Bio-Trap Study Wells
Figure 3:	Bio-Trap Study Design and Analytical Data – GMW-13
Figure 4:	Bio-Trap Study Design and Analytical Data – TC-6D
Figure 5:	Bio-Trap Study Design and Analytical Data – GMW-7R
Figure 6:	Remedial Layout – Former Source Area
Figure 7:	Remedial Layout

APPENDIX

Appendix A:	Bio-Trap Study Analytical Laboratory Report
Appendix B:	Amendment and Reagent Technical Data and SDS's
Appendix C:	DVT Boring Logs

ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BioAug	Bioaugmentation
BioStim	Biostimulation
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
COC	Chemical of Concern
DAP	Diammonium Phosphate
DO	Dissolved Oxygen
DPT	Direct push testing
DVT	Design verification testing
EBAC	Total Eubacteria
EDO	Ethylbenzene/Isopropylbenzene Dioxygenase
EOS	EOS Remediation
gpm	gallons per minute
IDNR	Iowa Department of Natural Resources
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
ORP	Oxidation-Reduction Potential
O ₂	Oxygen
PDB	Passive diffusion bags
PHE	Phenol Hydroxylase
psi	pounds/square inch
PSWP	Pilot Study Work Plan
ROI	Radius of influence
SDS	Safety data sheets
TPH	Total Petroleum Hydrocarbons
µg/l	micrograms per liter

1. INTRODUCTION

1.1 Purpose of Pilot Study Design Plan

Ramboll U.S. Corporation (Ramboll), on behalf of Vogel Paint and Wax Company, Inc. (Vogel), has prepared this Pilot Study Design Plan Addendum (Design Plan) for the site located on Grant Avenue Between 490th and 500th street in the City of Maurice, Sioux County, Iowa ("the Site"; Figure 1). This Design Plan is an addendum to the May 24, 2019 Pilot Study Work Plan (PSWP) approved by United States Environmental Protection Agency – Region 7 (USEPA) via email May 30, 2019. The PSWP presented the approach for a pilot in-situ bioremediation study to evaluate the enhancement of groundwater remediation at the site. The purpose of this Design Plan provides the details for the basis of design and implementation of in-situ bioremediation pilot study injection task.

The background, site conditions, pilot study approach and other supporting information was previously presented in the May 24, 2019 PSWP.

2. BIO-TRAP STUDY - BASIS OF DESIGN

As presented in the PSWP, a Bio-Trap® study was proposed to determine the in-situ bioremediation treatment design for the contaminants in the various portion of the groundwater plume slated for in-situ bioremediation. The study was conducted in partnership with Microbial Insights, Inc. (Microbial Insights), an environmental biotechnology company located in Rockford, Tennessee. In general, a Bio-Trap® study measures the microbial population over a period of time under specified conditions. Results of the Bio-Trap® study are used to determine the need for and quantity/dosing of biostimulation amendments, along with possible bioaugmentation in each application area (e.g., grid design in former source area and permeable reactive barriers in remaining portion of the plume).

2.1 Bio-Trap® Study Design

Bio-Trap® units were placed in wells GMW-13 (former source area), TC-6D (middle portion of plume) and GMW-7R (on-site downgradient portion of plume) (Figure 2) on March 25, 2019 and remained in the wells until they were removed to be sent for laboratory analysis on May 9, 2019. Using well GMW-13 was a change from the plan as presented in the PSWP. The plan presented to the PSWP intended that a unit would be placed in Well GMW-14 (former source area); however, due to a bend in the upper portion of the well casing the unit was unable to be deployed in Well GMW-14. As an alternative, the unit was placed in Well GMW-13 because it is also located in the other former source area.

At each of the three monitoring wells (GMW-13, TC-6D, and GMW-7R), four Bio-Trap® units [one control (monitored natural attenuation, MNA), two biostimulation, and one bioaugmentation] were vertically installed within the well screen interval. The biostimulation, or BioStim, unit is a Bio-Trap® unit with a substrate amendment (e.g., oxygen-based or nutrient-based). The oxygen-based amendment is EO_x, a time-release calcium peroxide (CaO₂) that accelerates aerobic degradation, developed and supplied by EOS Remediation (EOS). The nutrient-based amendment used was Diammonium Phosphate (DAP), which is a soluble micro-nutrient that provides nitrogen and phosphorus for microbial growth. The bioaugmentation, or BioAug, unit is a Bio-Trap® unit with Bio-Sep® beads were pre-inoculated with a bacterial cultural (BAC-TPH [total petroleum hydrocarbons]) and a substrate amendment, also provided by EOS.

Results from vertically distributed passive diffusion bags (PDBs) placed in selected wells, including wells GMW-15, TC-6D and GMW-7R, in 2015 and 2016 (Annual Groundwater Monitoring reports, GeoTek) suggest possible vertical chemical gradient in the water-bearing zone (i.e., possible decreasing chemical of concern (COC) concentrations with depth). To account for possible highest concentrations of COCs in the upper portion of the water-bearing zone, the four Bio-Trap® units were placed in the following vertical order:

- The two BioStim Units (EO_x and EO_x+DAP) were placed in the top vertical position anticipated to have the highest COC concentrations. Biostimulation (EO_x+DAP) is anticipated to be the primary pilot application,
- The BioAug unit was below the BioStim unit,
- The Bio-Trap® control unit (MNA), which contained no amendments, were installed at the bottom, with the exception of Well TC-6D. Due to a short well screen in Well TC-6D, the MNA unit was placed at the top above the well screen interval for that well. Placing

the MNA unit above the well screen in Well TC-6D, due the well screen interval being shorter than the string of Bio-Trap units, allows for the BioStim and BioAug units to be in a position in the well screen comparable to the placement of these units in the other wells (GMW-13 and GMW-7R).

- Baffles were used to physically isolate each treatment unit to eliminate vertical transport or “cross-talk”. A cross-section of the deployment depths of the Bio-Trap® units in each well are presented in Figures 3, 4 and 5.

Prior to deployment of the Bio-Trap® units and just prior to removal of the units, depth to water was measured in each well, and a down-well field water quality probe was placed in the wells to measure dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, temperature and total dissolved solids.

Following retrieval of each unit at the end of the study, the units were shipped to Microbial Insights and each unit was analyzed for microbial population parameters (total eubacteria [EBAC], ethylbenzene dioxygenase [EDO] and phenol hydroxylase [PHE]); the COC (benzene, toluene, ethylbenzene, and xylenes (BTEX)); and anions (chloride, nitrate, nitrite, sulfate, and orthophosphate).

2.2 Bio-Trap® Study Results

Significant reduction in COCs concentrations occurred in the BioStim Units. A summary of the results for each well is presented below. The analytical results from the Bio-Trap® units are presented in Table 1. Results of the field readings at the beginning and end of the Bio-Trap® unit deployment are summarized in Table 2. The analytical laboratory report from Microbial Insights is included as Appendix A.

GMW-13

The largest decrease in BTEX concentrations occurred in the EO_x unit compared to the MNA unit. Significant decreases in BTEX concentrations were also measured in the EO_x+DAP and BioAug units compared to the MNA unit.

Based on prior PDB testing results, the highest concentrations of BTEX compounds occurred in the upper portion of the water-bearing zone, with decreasing concentrations at depth. Since the highest concentrations of BTEX compounds was measured in the MNA unit set at the deepest depth of the units deployed in Well GMW-13, the initial concentrations of BTEX compounds in the other units should have been initially higher than what was measured in the MNA unit. The significant decreases in BTEX concentrations in the other units are concluded to be the result of the biostimulation and bioaugmentation materials placed in those units. Other noteworthy findings include the following:

- The EO_x unit experienced an EBAC decrease of three orders of magnitude lower in compared to the MNA Unit.
 - With the significant decrease in BTEX concentrations in this unit noted above the reduction of EBAC in this unit may have been the result of microbial die-off once the food source (i.e., BTEX) was depleted. Similar trends were measured in EDO and PHE gene levels as was observed in the EBAC microbial population. Same conclusions presented for the EBAC results apply to the EDO and PHE results.
- EO_x+DAP and BioAug produced an increase in microbial population

- EBAC increased one order of magnitude in the EO_x+DAP amendment and bioaugmentation units compared to the MNA unit
- Low concentrations of anions were measured in the units.
 - Natural conditions in the groundwater appear to be nutrient-limiting.
 - Low concentrations of nitrate/nitrite and phosphorus in the EO_x+DAP unit may indicate that the DAP nutrients were being consumed by the native microbial population.
- There was a significant increase in DO in this well during the pilot study.
 - Low oxygen (DO) conditions were present in the well at the beginning of the Bio-Trap study.
 - When the units were pulled at the end of the study period, bubbling was observed from the EO_x unit.
 - It is not known what caused the bubbling that was observed, but the bubbling most likely resulted in the increased DO measured in Well GMW-13.

TC-6D

COC concentrations were reduced to below detectable concentrations in the EO_x unit. BTEX contaminants were below their reporting limits in the EO_x amendment unit, indicating that this amendment had the greatest affect in reducing BTEX concentrations in this well. Other noteworthy findings include the following:

- EDO gene levels decreased by two orders of magnitude under biostimulation and, bioaugmentation units relative to the MNA unit, indicating that neither biostimulation or bioaugmentation enhanced the genetic potential for aerobic bioremediation of ethylbenzene contaminants via this pathway.
- PHE gene levels increased in the BioAug unit compared to the MNA units, indicating the genetic potential for the aerobic biodegradation of BTEX appeared to be enhanced under bioaugmentation conditions.
- Ethylbenzene and xylene concentrations were highest in the bioaugmentation unit, which was in the deepest position in this well. Concentrations of benzene, toluene and xylenes were detected in the MNA unit set above the screen interval in this well (Figure 3). Contaminant results suggest that there may be vertical heterogeneity in the subsurface distribution of contaminants in this well.
- EBAC concentrations were similar in all units and were not substantially enhanced in the BioStim and BioAug units compared to MNA units.
- Low concentrations of anions were measured in the units.
 - Natural conditions in the groundwater appear to be nutrient-limiting.
 - Low concentrations of nitrate/nitrite and phosphorus in the EO_x+DAP unit may indicate that the DAP nutrients were being consumed by the native microbial population.
- Low DO conditions were present in the well at the beginning of the Bio-Trap® study.

- Field-measured water quality parameters were similar at the time the units were removed from the well. This is typical as reactions between the groundwater and the amendments occur within the units themselves and generally do not permeate into the groundwater within the well.

GMW-7R

Low to non-detect concentrations of COCs were measured in the MNA unit and the other units. The low to non-detect COC concentrations overall make it difficult to evaluate the Bio-Trap units deployed at this location; however, the EO_x+DAP unit appears to have had the most significant influence in reducing the low COC concentration below non-detect levels.

- EBAC concentrations increased by an order of magnitude in the EO_x and BioAug units compared to MNA unit which may indicate enhancement of indigenous bacterial growth under these units.
- EDO gene levels decreased by three orders of magnitude in the EO_x+DAP and BioAug units relative to the MNA unit, indicating that neither EO_x+DAP nor bioaugmentation enhanced the genetic potential for aerobic bioremediation of ethylbenzene contaminants via this pathway.
- PHE gene levels increased compared to MNA levels in the EO_x and BioAug units, indicating enhanced genetic potential for aerobic BTEX biodegradation under conditions of EO_x amendment and bioaugmentation.
- Xylenes were the primary COCs present in the Bio-Trap® units deployed.
 - in general, xylenes concentrations were below the reporting limit in all of the Bio-Trap® units, except for the EO_x amended unit, which contained 252 µg/L of total xylenes.
 - The contaminant data suggested the possibility of vertical heterogeneity in the subsurface distribution of BTEX hydrocarbons.
- No COC were detected in the EO_x+DAP unit, possibly indicating that this amendment had the greatest affect in reducing BTEX concentrations in this well.
- Low concentrations of anions were measured in the units.
 - Natural conditions in the groundwater appear to be nutrient-limiting.
 - Low concentrations of nitrate/nitrite and phosphorus in the EO_x+DAP unit may indicate that the DAP nutrients were being consumed by the native microbial population.
- Slightly higher concentrations of sulfate may indicate some natural degradation occurring in this well.
- Moderate to high DO conditions were present in the well at the beginning of the Bio-Trap® study.
 - Field-measured water quality parameters were similar at the time the units were removed from the well. This is typical as reactions between the groundwater and the amendments occur within the units themselves and generally do not permeate into the groundwater within the well.

In all three wells groundwater levels rose in the wells on average 1.17 feet over the deployment of the Bio-Trap® units (Table 2 and Figures 3, 4 and 5). This rise in water levels during deployment may have affected vertical distributions of the contaminants of concern within the water columns in the wells.

2.3 Bio-Trap® Study Conclusions – Basis of Design

A sufficient native microbial populations exist in the wells where the Bio-Trap study was conducted which represents the former source areas, middle section and downgradient portions of the dissolved-phase contaminant groundwater plume. These native conditions provide a basis for biostimulation of the existing microbial populations to increase and sustain the populations to allow for enhanced biodegradation of the COCs.

Based on the analytical results the largest decrease in the BTEX concentrations in each well occurred in the Bio-Trap® units that were amended with biostimulants EO_x and/or EO_x +DAP. Native groundwater conditions also are nutrient deficient; therefore, the addition of nutrients (DAP) is recommended to enhance microbial growth for the reduction of the contaminants of concern.

Based on the results of the Bio-Trap® study, Ramboll has determined that EO_x +DAP would be the most effective materials to be injected into the water-bearing zone to enhance and accelerate bioremediation of the groundwater contaminant plume. The combination of EO_x +DAP will provide an appropriate amount sustained oxygen to increase aerobic degradation of the COCs and also provide nutrients to continue to sustain the increased microbial populations during biodegradation.

Results of the Bio-Trap study was shared with EOS to determine dosage parameters for injection of the materials detailed in Section 3.

3. MATERIALS AND INJECTION VOLUME AND LAYOUT

Based on the results of the Bio-Trap® study EO_x and DAP was selected to be the materials to be injected to promote the most effective stimulus for the native microbial population and to sustain those expanded microbial populations for an extended period of time during degradation of the volatile organic contaminants of concern. PlumeStop was selected to provide a barrier for off-site migration of the contaminants. EO_x+DAP injection adjacent and upgradient to the PlumeStop barrier will allow for the degradation of the contaminants sequestered by PlumeStop.

Further details regarding these materials and their placement in the water-bearing zone is presented below.

3.1 EO_x, DAP and PlumeStop®

EO_x is composed of calcium peroxide, which contains percent oxygen (by weight) and can release oxygen to enhance aerobic bioremediation a variety of contaminants, including BTEX compounds. The use of EO_x promotes increased contaminant removal and provides a sustained release of oxygen (up to 12 months). EO_x comes in a dry powder form with micron scale (<74 micron) particles for easy mixing and maximum distribution into the water-bearing zone.

Diammonium phosphate (DAP) is a soluble micro-nutrient that is being used in conjunction with EO_x to provide extended term nutrients to the native microbial population in the areas of injection. DAP will be added to provide both nitrogen and phosphorous enrichment, which are both nutrients to aid in sustaining the microbial population as it blooms for the injection of EO_x.

PlumeStop® is a fast-acting, sorption-based technology being applied along the downgradient property line portion of the contaminant plume. PlumeStop® is a liquid activated carbon developed by Regenesi® Remediation Solutions and Products (Regenesi) and has a high affinity for sorption of BTEX compounds and captures and concentrates these dissolved-phase contaminants. Once the contaminants are absorbed onto the injected matrix, biodegradation of the contaminants occur at an accelerated rate through the adjacent application of EO_x and DAP. A single application of PlumeStop® is estimated to remain functional for approximately 10->20 years.

Technical data and safety data sheets (SDS) for EO_x DAP and PlumeStop® are included in Appendix B.

3.2 Former Source Area Injection (EO_x+DAP)

Injections will be applied in a grid application over an approximate 20,000-square-foot area. A radius of influence (ROI) of 7.5 feet is estimated at each injection point for a total of 84 injection points (Figure 6). Based on the coarser grained nature of the water-bearing zone and historical groundwater extraction rates, a 7.5-foot ROI was used as a conservative ROI for injection of the materials.

The materials will be injected within the water-bearing zone at depths ranging from approximately 14-24 feet within the former source area.

The mass of EO_x injected at the site was determined based on the contaminant concentrations using a stoichiometric calculation approach, hydrogeologic parameters and assumptions regarding native oxygen demand within the water-bearing zone. At each injection point in the former source area, a planned 170 lbs. of EO_x + 1.7 lbs DAP (DAP will be added at a ratio of 1/100 to the amount of EO_x) and an estimated 826 gal. of water. A total of 14,196 lbs. of EO_x + 143 lbs. DAP + a 69,361 gal. of water is planned to be injected in the former source area.

Based on prior multi-depth diffusion bag sampling performed by GeoTek, and the results from the Bio-Trap study, there appears to be a vertical gradient of the distribution of BTEX concentrations in the water column (i.e. reducing concentrations with depth within the water-bearing zone). To address this vertical concentration gradient in the water-bearing zone; 70% of the mass of the EO_x +DAP will be injecting in the top half of the injection interval and 30% injection into the bottom half of the injection intervals.

The volume of material being injected into the injection interval is based on the pore volume estimate within the estimated ROI. A conservative approach of adding material equal to 25% of the total pore volume within the ROI is the approach taken to provide ample material within the injection area. The distribution of the materials within the ROI may not require a full 25% pore volume of fluid. Initial injection will be conducted at injection points surrounding Well GMW-14 while water level and dissolved oxygen (DO) is measured in that well. If rapid and significant rise in water levels and increase in DO is measuring in Well GMW-14 then that volume of water will be reduced and potentially reduced to a maximum of one-half the initially planned volume of water; however, the mass of EO_x + DAP will not be reduced.

A summary of the injection volumes and concentrations of EO_x in each set of injection points is provided in Table 3.

3.3 Injection in Downgradient and Off-Site Portion of the Plume (EO_x +DAP)

The downgradient and off-site portion of the plume will receive strategically-placed lines of injection points generally transecting the width of the plume, creating permeable treatment zones. Five injection lines have been designed for bioremediation of the plume downgradient of the former source areas. These five injections transect lines/treatment zones will be installed with the following configurations (from north to south, Figure 7):

- GMW-10R Transect - 105-feet total length; 7 injection points; injection depth interval 10 feet (14 – 24 feet below ground surface, [bgs]).
- TC-2/MW-4R Transect - 300-feet total length; 20 injection points; injection depth interval 14 feet (14 – 28 bgs).
- GMW-15/GMW-16 Transect - 255-feet total length; 17 injection points; injection depth interval 10 feet (40 – 50 bgs).
- GMW-20/GMW-7R (downgradient property line) Transect - 195-feet total length; 13 injection points; injection depth interval 8 feet (41 – 49 bgs).
- GMW-21/GMW-22 (off-site) Transect - 150-feet total length; 10 injection points; injection depth interval 10 feet (40 – 50 bgs).

The concentration of EO_x injected in the treatment lines is a slightly lower dosage, as a result of lower COC concentrations downgradient of the former source area, that will be applied in the former source area. The total mass of EO_x to be injected in each line was determined from a volumetric approach as opposed to a stoichiometric approach. The total mass (lbs.) of EO_x and estimated total volume of the product water mixture is summarized in Table 3. As in the former source area, DAP will be added at a ratio of 1/100 to the amount of EO_x.

To address the vertical concentration gradient in the water-bearing zone; 70% of the mass of the EO_x+DAP will be injecting in the top half of the injection interval and 30% injection into the bottom half of the injection intervals.

The volume of material being injected into the injection interval is based on the pore volume estimate within the estimated ROI. A conservative approach of adding material equal to 25% of the total pore volume within the ROI is the approach taken to provide ample material within the injection area. The distribution of the materials within the ROI may not require a full 25% pore volume of fluid. Based on the injection process in the former source area the volume of water may be reduced and potentially reduced to a maximum of one-half the initially planned volume of water; however, the mass of EO_x + DAP will not be reduced.

3.3.1 PlumeStop® Barrier

To provide longer term control of possible off-site migration of residual contaminant concentrations, the application of a sorption-based technology will be added to the treatment barrier zone along the downgradient property boundary. The sorption material is a liquid activated carbon (PlumeStop®) developed by Regenesis® Remediation Solutions and Products (Regenesis). This is a fast-acting, sorption-based technology that captures and concentrates dissolved-phase contaminants. Once the contaminants are absorbed onto the injected matrix, biodegradation of the contaminants occur at an accelerated rate.

To finalize the design of this barrier, design verification testing (DVT) borings were completed adjacent to the planned PlumeStop® injection location. Two soil borings were drilled 5-feet downgradient of the planned PlumeStop® injection line (see Figure 7). A third boring was proposed but was unable to be completed due to rain making that location inaccessible. Based on the information gathered from the two completed borings, sufficient information was gathered to complete the PlumeStop® barrier design.

The purpose of the borings was to obtain information regarding the characteristics of the water-bearing zone for determine of final injection design. Continuous coring was completed from a depth of 35 feet (anticipated depth to water-bearing zone was approximately 40 feet) to the several feet below the bottom of the water-bearing zone. Boring logs from the two borings (DVT-1 and DVT-2) is included in Attachment C. The water-bearing zone is overlain by a thick and competent clay layer and underlain by a similar clay layer. The water-bearing zone is comprised of a medium to coarse grained sand and small gravel layer that is approximately 9 feet in thickness. The water-bearing zone was encountered at an approximated depth of 41 – 43 feet and is under confining pressure with water level rising to a depth of approximately 34 feet below ground surface.

Based on the lithology and hydrogeology of the water-bearing zone, PlumeStop® will be injected over the entire thickness of the water-bearing zone:

- Injection line – 200 feet in length

- Number of injection points – 33 (6-foot spacing between points, to provide a 30% overlap for complete barrier coverage)
- Injection depth interval/thickness – 41-44 feet to 50-53 feet / 9-11 feet
- Amount of PlumeStop® – 12,000 lbs. (1,332 gal.)
- Total volume injected (mixed with water) – 18,000 gal.

Details of the injection implementation plan for PlumeStop® is presented in Table 4.

The DVT borings were completed as 2-inch diameter temporary wells screened across the water-bearing zone. These temporary wells will be monitored during the injection of the PlumeStop® to verify the lateral distribution of the material to assure that complete coverage of the materials is achieved within the water-bearing zone along the length of the barrier. The temporary wells will be properly abandoned following the completion of the installation of the PlumeStop® barrier.

4. INJECTION METHODOLOGY

4.1 EO_x + DAP

A track mounted 7000 series Geoprobe direct push testing rig will be used to insert tooling to the target depths for the injection of the materials detailed in Section 3. Custom built lateral injection point tools will be used to conduct high volume/high pressure targeted top-down 2' interval injections for EO_x+DAP slurry injections. The approach is to pressure jet the material laterally into the formation through small ports in order to obtain a maximum radius of distribution.

The injection contractor will be using double-pump Clean-Inject™ system. Clean-Inject™ is a patent-pending Remediation System that is capable of injecting Powdered Activated Carbon or other powdered reagents mixed with water into the subsurface at narrow and precise targeted intervals to remediate impacted soil and groundwater. This system allows precise placement of all types of reagents, reduces surfacing issues, and significantly improves treatment performance by insuring the most contact of reagent and contaminants. This system has two D35 Wanner positive displacement pumps that are plumbed in parallel and allows up to 70 gallons per minute (gpm) at up to 1200 pounds/square inch (psi). They can be operated individually or together when needed. This allows for better jetting action which can help improve ROI in coarser grained sands.

A digital flow rate and pressure monitoring system assists in monitoring the subsurface behavior of the injections as they proceed, allowing the operator to make real time field adjustment when issues are observed and helps reduce surfacing issues.

A lower to moderate injection pressure regime (<10 gpm and <100 psi) will be tried initially with monitoring of a nearby groundwater monitoring wells (GMW-13 and or GMW-14) will be tried initially and flow rates and pressure will be adjusted as needed to meet planned ROI (minimum 7.5 feet).

Materials will be injected at one to two injection points at a time. Depending on efficiency of the injection of the materials between 4 – 10 injection points (approximately 7000-gal – 18,000-gal) will be completed per day.

4.2 PlumeStop®

Similar equipment and approach detailed above will be used to inject the PlumeStop® slurry. The primary difference from the injection of the EO_x+DAP slurry is that PlumeStop® will be injected at a slower rate. The material will be injected into the target depths at 3 – 4 injection points simultaneously. The injection contractor anticipates that 2,000 – 3,000-gal of PlumeStop® slurry will be injected per day.

5. SCHEDULE

The following is a summary of the schedule for the implementation of scope of work detailed in this Design Plan. The implementation of the scope of work detailed in this Design Plan is estimated to be conducted over a 7-week period starting October 8 through November 23, 2019.

The injection of EOx+DAP amendments will be conducted starting October 8th and will be implemented on a 10-day on, 4-day off schedule estimated to take a total of 35-days of injection. The work is planned to be conducted during the following schedule (contingent on weather conditions):

- October 8 – 17
- October 22 – 31
- November 5 – 14
- November 19 – 23

The Injection of PlumeStop® will be conducted starting October 8th by a second crew and is anticipated to be completed in 6 – 9 days.

6. REFERENCES

GeoTek Engineering and Testing Services (GeoTek). 2018 Annual Monitoring Report, Vogel Paint & Wax Co. Site, Maurice, Iowa. May 2019.

Ramboll. Pilot Study Work Plan for Enhancement Of Groundwater Remediation Vogel Paint & Wax Co. Grant Avenue Between 490th And 500th Street, Maurice, Iowa. May 24, 2019.

TABLES

Table 1. Bio-Trap Study Analytical Results

Vogel Paint Wax Co.

Maurice, Iowa

Bio-Trap Unit	Microbial Populations			Contaminant of Concern				Anions				
	EBAC	EDO	PHE	Benzene	Toluene	Ethyl- benzene	Xylenes	Chloride	Nitrate	Nitrite	Sulfate	Ortho- Phosphate
	(cells/bd)			(µg/L)				(mg/L)				
GMW-13												
EOx	7.41E+04	6.49E+02	8.20E+02	1.3	384	387	1,680	15.3	0.6 (J)	<0.1	7.7 (J)	0.07 (J)
EOx+DAP	1.33E+08	1.29E+06	2.05E+05	<5.0	905	1,700	17,400	22.4	<0.1	<0.1	0.3 (J)	<5.0
TPH BioAug	9.35E+08	1.58E+04	4.66E+07	3.9 (J)	4,660	10,100	37,700	31.7	<0.1	<0.1	<5.0	0.23
MNA	6.89E+07	2.71E+05	1.40E+05	<25.0	6,700	15,600	72,400	13.3	<0.1	<0.1	8.2	<0.13
TC-6D												
MNA	1.62E+08	1.58E+05	3.87E+05	0.6 (J)	<10.0	87.2	108	21.2	<0.1	<0.1	8.8	<0.13
EOx	5.50E+08	5.93E+03	8.74E+05	<1.0	<1.0	<1.0	<3.0	6.2 (J)	<0.1	<0.1	3.6 (J)	<0.13
EOx+DAP	7.24E+07	1.36E+03	1.41E+05	<1.0	<1.0	28.3	171	0.8 (J)	<1.0	<1.0	0.8 (J)	0.08 (J)
TPH BioAug	6.57E+08	4.30E+03	4.35E+07	<100	<100	589	1,930	22.9	<1.0	<1.0	0.7 (J)	0.87
GMW-7R												
EOx	2.73E+08	2.25E+05	1.93E+05	<1.0	<1.0	<1.0	251	6.0 (J)	<1.0	<1.0	7.8 (J)	0.06 (J)
EOx+DAP	6.42E+07	4.90E+02	6.03E+04	<1.0	<1.0	<1.0	<3.0	22.2	<0.1	<0.1	74.8	0.06 (J)
TPH BioAug	3.71E+08	7.09E+02	2.47E+07	<1.0	<1.0	0.5 (J)	1.6 (J)	31	<0.1	<0.1	100	0.20
MNA	4.16E+07	3.45E+05	7.02E+04	<1.0	<1.0	<1.0	2.5 (J)	31	<0.1	<0.1	103	0.29

Notes:

bd - bead

EBAC - Total Eubacteria

EDO - Ethylbenzene dioxygenase

µg/l - micrograms per liter

mg/l - milligrams per liter

PHE - Phenol Hydroxylase

J - Estimated result below reporting limit but above minimum detection limit

Bio-Trap Units: Listed in vertical order they were placed in the wells

Monitored Natural Attenuation (MNA) - control unit

EOx - calcium peroxide (slow-oxygen-releasing compound)

EOx+DAP - EOx + diammonium phosphate (nutrients)

TPH BioAug - bacterial culture BAC-TPH

Table 2. Bio-Trap Study Field Measurements and Water Quality Parameters

Vogel Paint Wax Co.

Maurice, Iowa

Well	Date	DTW	DO	ORP	pH	Temperature	TDS
		feet	mg/l	mV		°F	mg/L
GMW-13	3/25/19	13.80	0.54	84.4	6.80	47.1	605
	5/9/19	12.72	7.68	187.7	8.16	45.2	519
TC-6D	3/25/19	26.42	2.11	-101.2	7.10	50	462
	5/9/19	25.14	1.61	-149.4	7.68	49.9	436
GMW-7R	3/25/19	35.31	9.76	131.8	7.05	49.6	528
	5/9/19	34.15	6.54	268.6	6.90	49.6	616

Notes:

DTW - Depth to Water (from top of casing)

DO - Dissolved Oxygen

ORP - Oxidation-Reduction Potential

TDS - Total Dissolved Solids

Table 3. EOx Injection Plan Summary

Vogel Paint Wax Co.

Maurice, Iowa

Injection Volume Calculation Table							
Nearby Wells to Injection Lines	GMW-10R	TC-2/MW-4R	GMW-15	Prop. Line	Off-site	Source Area	TOTALS
INJECTION CONFIGURATION	One Row Barrier	One Row Barrier	One Row Barrier	One Row Barrier	One Row Barrier	Grid 200x100 ft	
No. of points	7	20	17	13	10	84	151
Point Spacing (ft)	15	15	15	15	15	15	
Presumed ROI (ft)	7.5	7.5	7.5	7.5	7.5	7.5	
Injection start depth (feet, bgs)	14	14	40	41	40	14	
Injection end depth	24	28	50	49	50	24	
LOCATION & INTERVAL CALC							
Treated Vertical Interval (ft)	10	14	10	8	10	10	
Injection Intervals/Point	5	7	5	4	5	5	
Vertical Injection Interval (ft)	2	2	2	2	2	2	
Circular Area Treated (ft ²)	177	177	177	177	177	177	
Soil Volume Treated (ft ³)	1,766	2,473	1,766	1,413	1,766	1,766	
Soil Pore Volume @ est 25%	442	618	442	353	442	442	
Pore Volume (gal)	3,303	4,624	3,303	2,642	3,303	3,303	
% Injected. Effective Pore Vol.	25%	25%	25%	25%	25%	25%	
Total Effective Pore Vol. (gal)	826	1,156	826	661	826	826	
Interval Injected Volume (gal)	165	165	165	165	165	165	
EOx per Point (lbs)	138	193	138	111	138	169	
EOx per Interval (lbs)	28	28	28	28	28	34	
EOx Mix Pounds per Gallon	0.17	0.17	0.17	0.17	0.17	0.20	
% EOx Mix by Weight	2.0%	2.0%	2.0%	2.0%	2.0%	2.5%	
TOTAL AREA CALC							
Total Soil Volume Treated (ft ³)	12,364	49,455	30,026	18,369	17,663	148,365	276,242
Total Injection Intervals	35	140	85	52	50	420	782
Total EOx per area (lbs)	966	3,860	2,346	1,443	1,380	14,196	24,191
Total mix water per area (gal)	5,780	23,120	14,037	8,588	8,257	69,361	129,143
Input Numbers							
Calculated Numbers							

Reference:

Application of EOS Remediation EOx for In-Situ Remediation of Contaminants at Vogel Paint Waste Site, Vista GeoScience, September 5, 2019.

Table 4. PlumeStop Application Design Summary

Vogel Paint Wax Co.

Maurice, Iowa

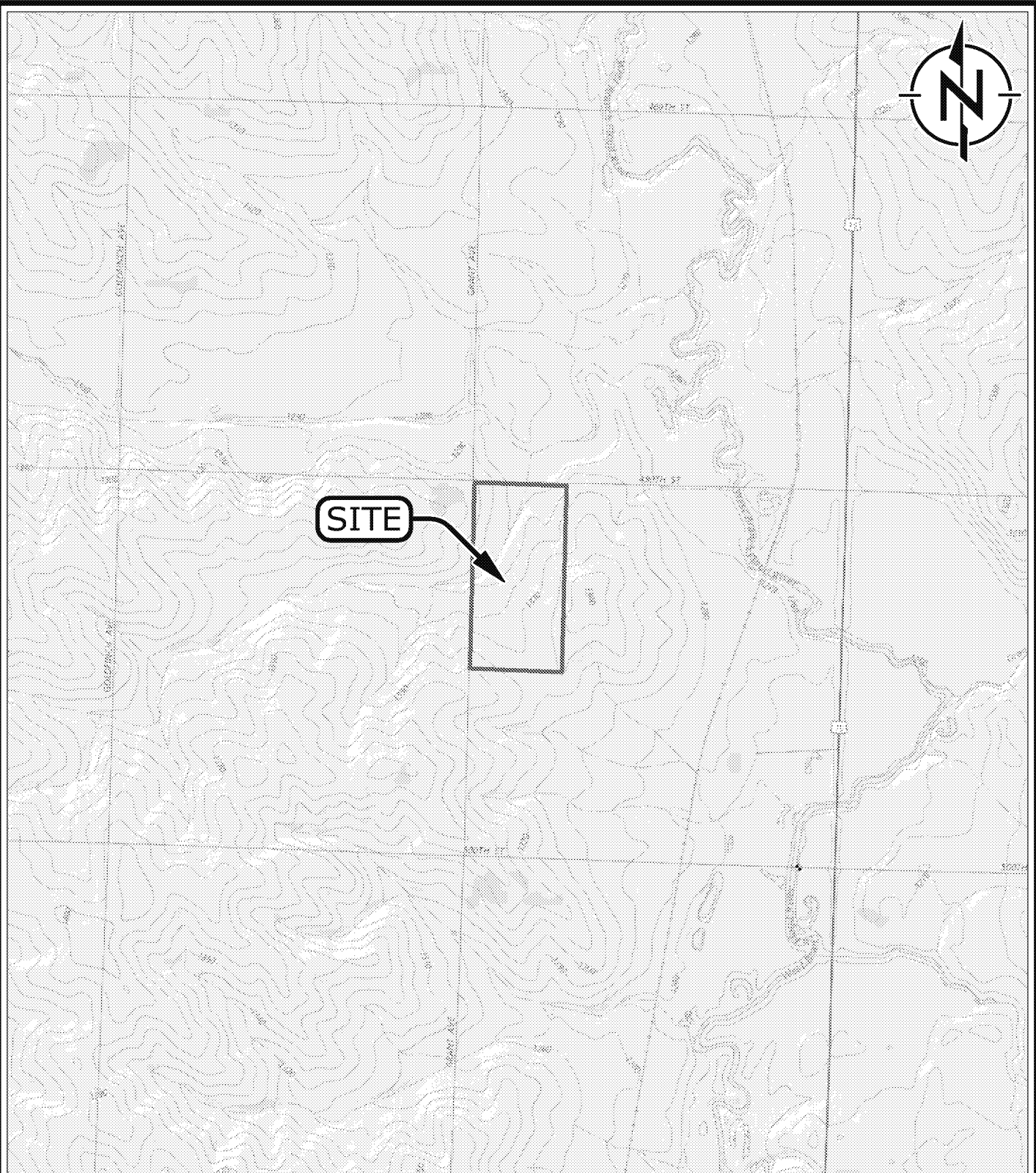
PlumeStop® Application Design Summary		
Dissolved Plume		
PlumeStop		Technical Notes/Discussion
Treatment Type	Barrier	<u>Injection Radius for Soil Coverage (ft-est.avg.)</u>
Distance Perpendicular to Flow (ft) Spacing Within Rows (ft)	200 6	4.0
Number of Rows	1	
DPT Injection Points	33	<u>PlumeStop Injection Concentration (mg/L)</u>
Average Top Application Depth (ft bgs) Average Bottom	41	15,845
Application Depth (ft bgs)	52	
PlumeStop to be Applied (lbs)	12,000	
PlumeStop to be Applied (gals)	1,332	
<u>Injection Volume Totals</u>		
Mixing Water (gal)	16,819	
Total Application Volume (gals)	18,151	All injection points must be abandoned with bentonite grout
Injection Volume per Point (gals)	550	

Reference:


PlumeStop Barrier, Vogel – Iowa, Regenesi Remediation Services, September 26, 2019.

FIGURES

Z:\01_Projects\Verdant -Vogel Paint Maurice IA\03_GIS\WYD\20180725 - Remedial Action Workplan Figures\Figure1_SiteMap_2018-07-23.mxd



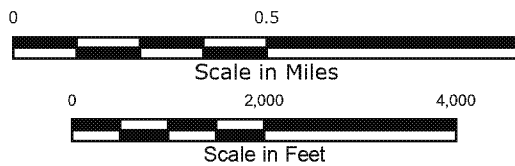
Legend

 Approximate Site Boundary

NOTES:
CONTOUR INTERVAL 20 FEET

SOURCE:
The National Map, 2018.

Map Scale: 1:24,000 Spatial Reference: NAD 1983 StatePlane Iowa North FIPS 1401 Feet; Map Center: 96°11'32"W 42°56'3"N



KEY MAP



Site Location Map

Vogel Paint Waste Site
Maurice, Iowa 51036

FIGURE

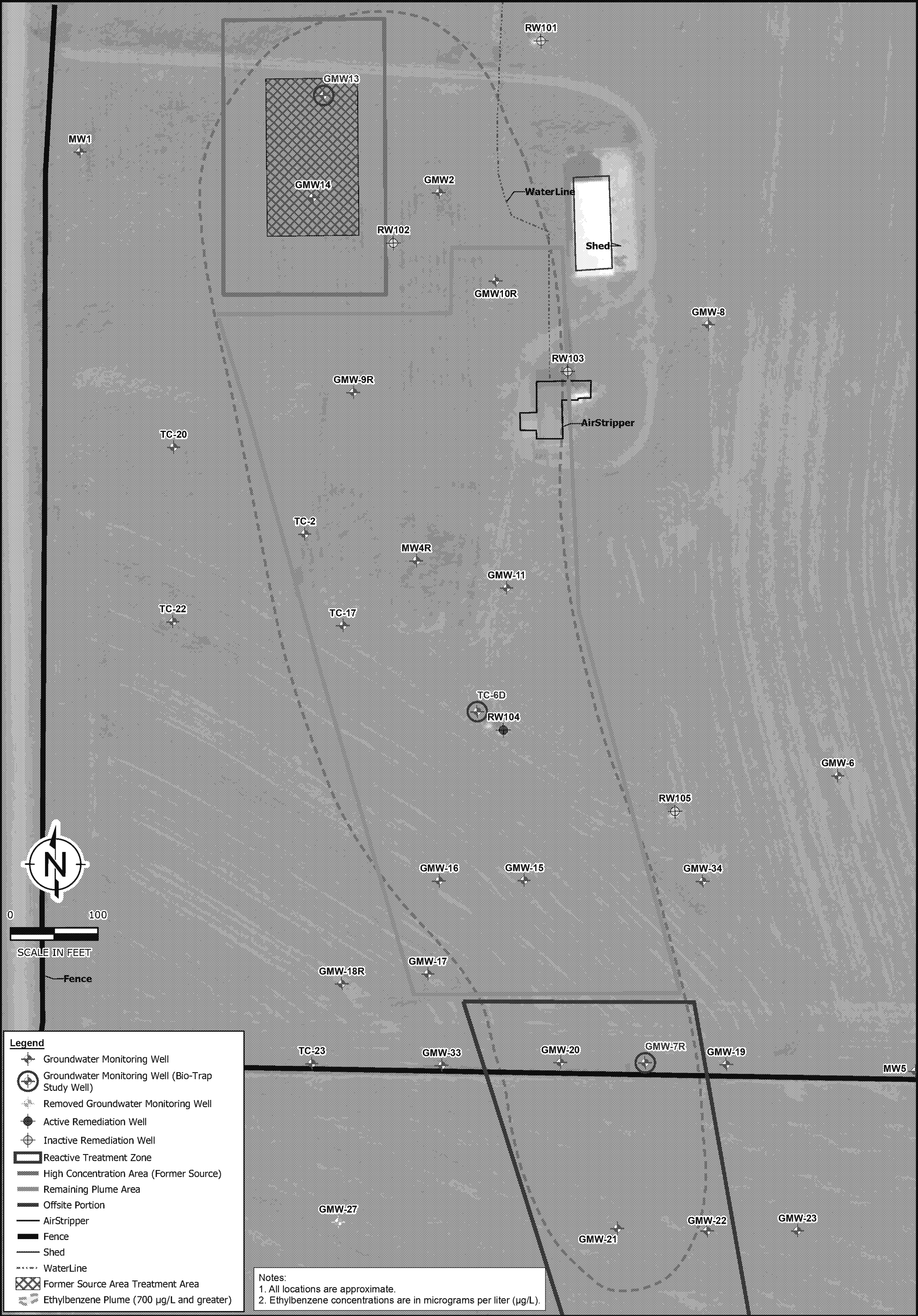
1

DRAFTED BY: J. KING

DATE: 7/25/2018

PROJECT: 1690001847-004

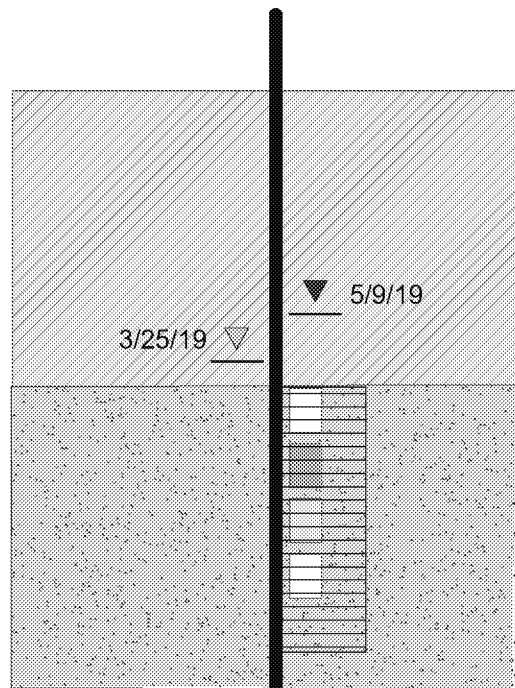
ED_004945A_00012998-00024



Z:\01_Projects\Verdant -Vogel Paint Maurice IA\03_GIS\WMD\20190610 - Client Meeting on 6-12-19\GMW13.mxd



Elevation in feet amsl



Legend

- Sand and Silty Sand
- Clay, Silty Clay, Sandy Silty Clay
- Groundwater Monitoring Well
- Screened Interval
- Groundwater Elevation Before Bio-Trap Placed
- Groundwater Elevation When Bio-Trap Retrieved
- Water Bearing Zone

Bio-Trap Units

- EOx
- EOx+DAP
- BioAug
- MNA

Notes:

1. Each Bio-Trap unit is 20 inches (1.67 ft) long with 0.5 ft space between each unit

GMW-13	Bio-Trap Units			
Microbial Population (cells/bd)	EOx	EOx+DAP	BioAug	MNA
EBAC	7.41E+04	1.33E+08	9.35E+08	6.89E+07
EDO	6.49E+02	1.29E+06	1.58E+04	2.71E+05
PHE	8.20E+02	2.05E+05	4.66E+07	1.40E+05
COCs (ug/l)				
Benzene	1.3	<5.0	3.9 (U)	<25.0
Toluene	387	1,700	10,100	15,600
Ethylbenzene	384	905	4,660	6,700
Xylenes	1,680	17,400	37,700	72,400

Figure Not to Scale



Bio-Trap Study Design and Analytical Data - GMW13

Vogel Paint Waste Site
Maurice, Iowa

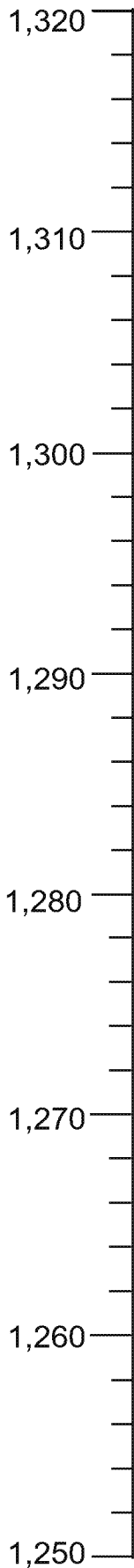
FIGURE
3

DRAFTED BY: J. Dishon

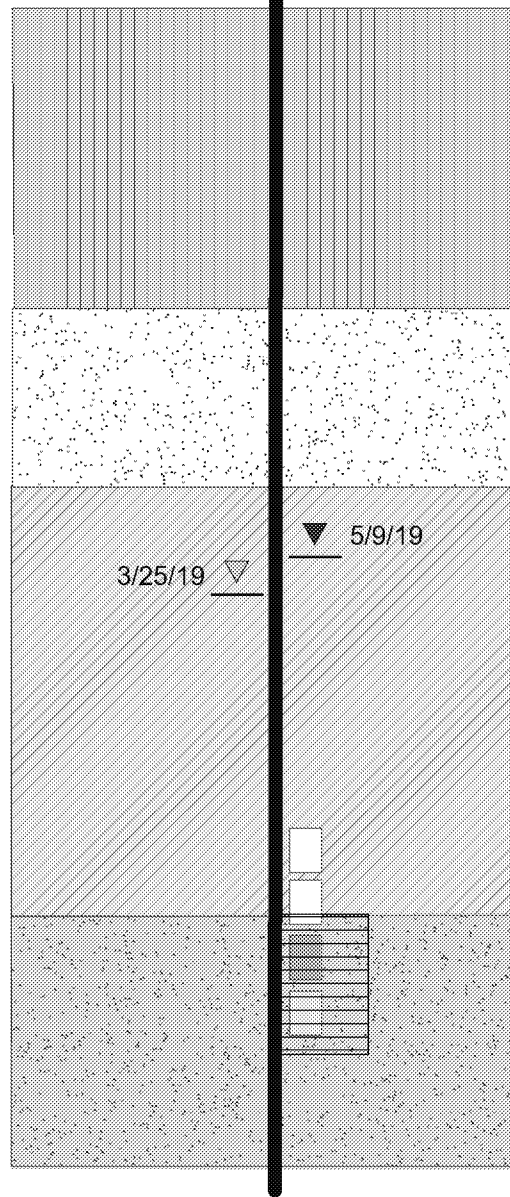
DATE: 6/12/2019

PROJECT: 1690001847-008

Z:\01_Projects\Verdant -Vogel Paint Maurice IA\03_GIS\MXD\20190610 - Client Meeting on 6-12-19\TC-6D.mxd



Elevation in feet amsl



Legend

- Sand and Silty Sand
- Silt, Clayey Silt
- Clay, Silty Clay, Sandy Silty Clay
- Groundwater Monitoring Well
- Screened Interval
- Groundwater Elevation Before Bio-Trap Placed
- Groundwater Elevation When Bio-Trap Retrieved
- Water Bearing Zone

Bio-Trap Units

- EOx
- EOx+DAP
- BioAug
- MNA

Notes:

- Each Bio-Trap unit is 20 inches (1.67 ft) long with 0.5 ft space between each unit

TC-6D	Bio-Trap Units			
Microbial Population (cells/bd)	MNA	EOx	EOx+DAP	BioAug
EBAC	1.62E+08	5.50E+08	7.24E+07	6.57E+08
EDO	1.58E+05	5.93E+03	1.36E+03	4.30E+03
PHE	3.87E+05	8.74E+05	1.41E+05	4.35E+07
COCs (ug/l)				
Benzene	0.6 (J)	<1.0	<1.0	<100
Toluene	87.2	<1.0	28.3	589
Ethylbenzene	<10.0	<1.0	<1.0	<100
Xylenes	108	<3.0	171	1,930

Figure Not to Scale

RAMBOLL

Bio-Trap Study Design and Analytical Data - TC-6D

Vogel Paint Waste Site
Maurice, Iowa

FIGURE

4

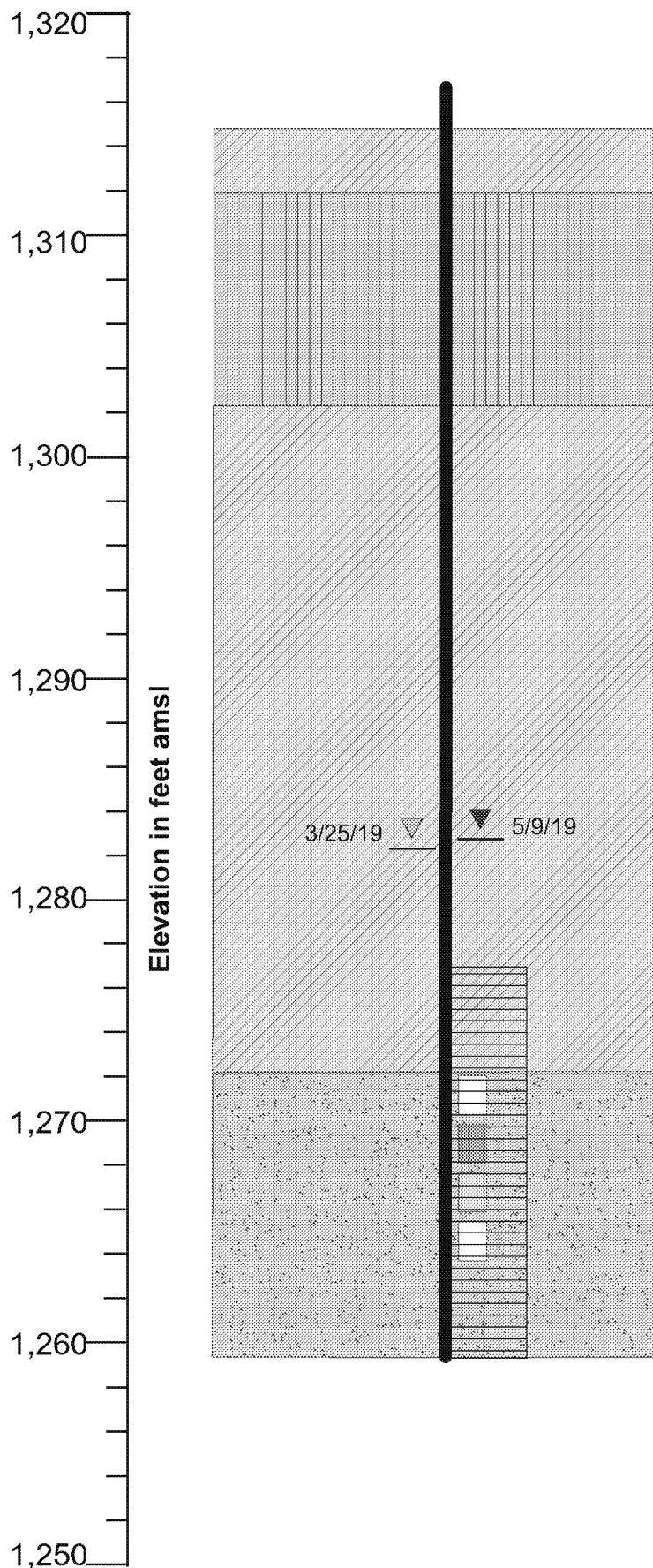
DRAFTED BY: J. Dishon

DATE: 6/12/2019

PROJECT: 1690001847-008

ED_004945A_00012998-00027

Z:\01_Projects\Verdant -Vogel Paint Maurice IA\03_GIS\MXD\20190610 - Client Meeting on 6-12-19\GMW-7R.mxd



Legend

- Sand and Silty Sand
- Silt, Clayey Silt
- Clay, Silty Clay, Sandy Silty Clay
- Groundwater Monitoring Well
- Screened Interval
- Groundwater Elevation Before Bio-Trap Placed
- Groundwater Elevation When Bio-Trap Retrieved
- Water Bearing Zone

Bio-Trap Units

- EOx
- EOx+DAP
- BioAug
- MNA

Notes:

1. Each Bio-Trap unit is 20 inches (1.67 ft) long with 0.5 ft space between each unit

GMW-7R	Bio-Trap Units			
Microbial Population (cells/bd)	EOx	EOx+DAP	BioAug	MNA
EBAC	2.73E+08	6.42E+07	3.71E+08	4.16E+07
EDO	2.25E+05	4.90E+02	7.09E+02	3.45E+05
PHE	1.93E+05	6.03E+04	2.47E+07	7.02E+04
COCs (ug/l)				
Benzene	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	<1.0	0.5 (J)	<1.0
Ethylbenzene	<1.0	<1.0	<1.0	<1.0
Xylenes	251	<3.0	1.6 (J)	2.5 (J)

Figure Not to Scale

RAMBOLL

Bio-Trap Study Design and Analytical Data - GMW-7R

Vogel Paint Waste Site
Maurice, Iowa

FIGURE

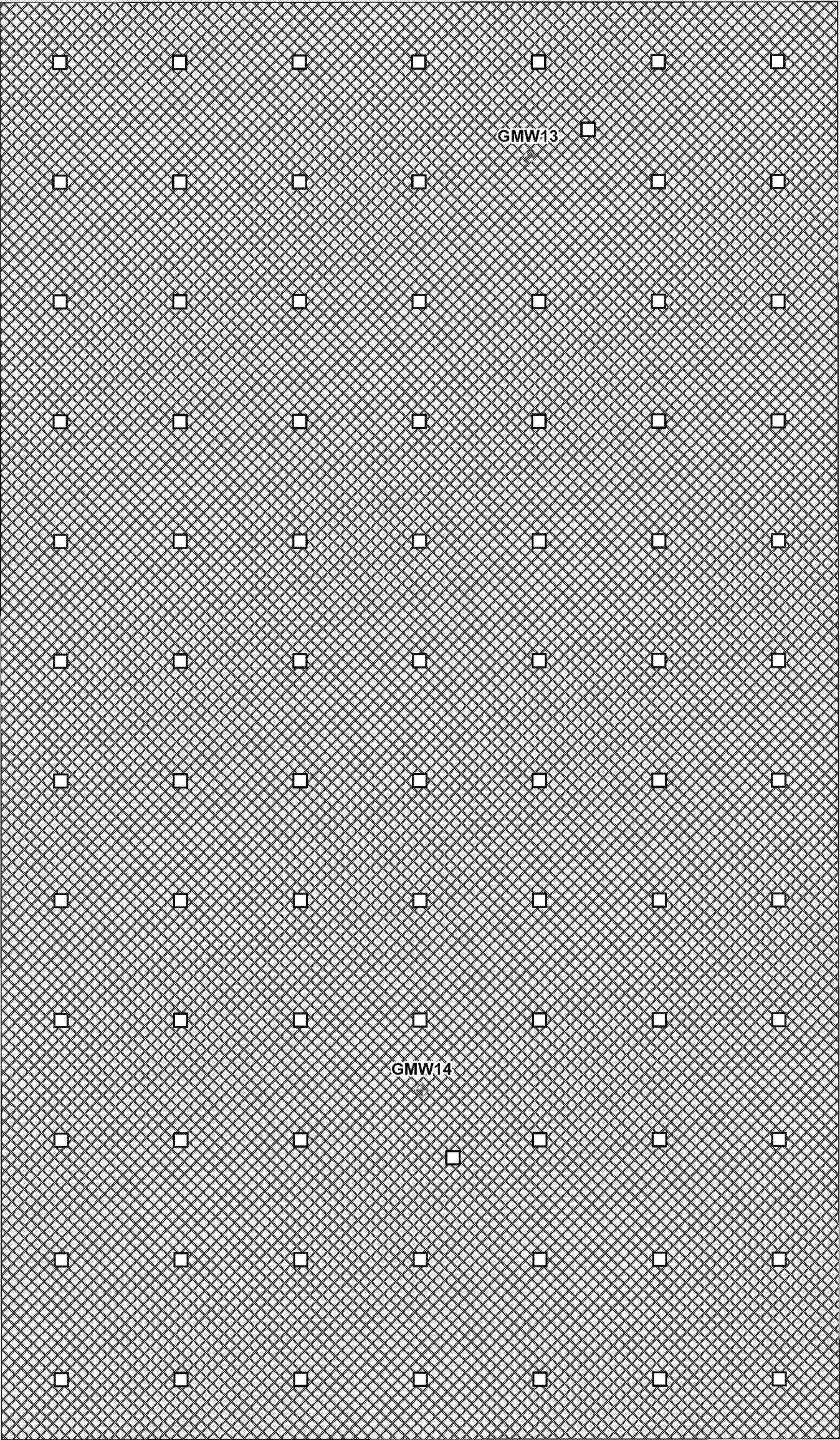
5

DRAFTED BY: J. Dishon

DATE: 10/1/2019

PROJECT: 1690001847-008

ED_004945A_00012998-00028



Legend

Source Area Injection Point

Groundwater Monitoring Well

Removed Groundwater Monitoring Well

Active Remediation Well

Inactive Remediation Well

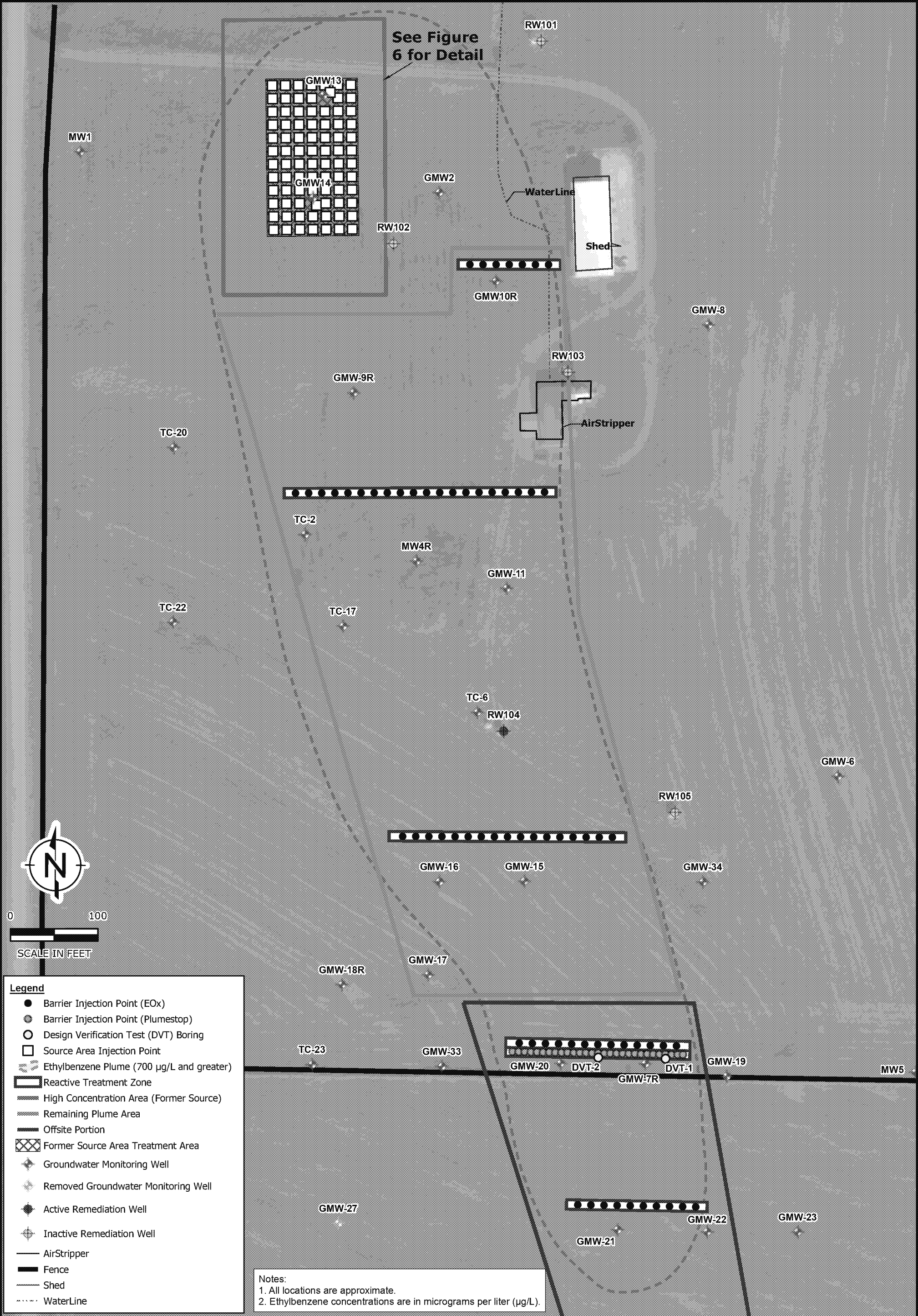
Former Source Area Treatment Area

Ethylbenzene Plume (700 µg/L and greater)

Notes:
1. All locations are approximate.
2. Ethylbenzene concentrations are in micrograms per liter (µg/L).

015

SCALE IN FEET
1 inch equals 15 feet



APPENDIX A
BIO-TRAP STUDY ANALYTICAL LABORATORY REPORT

SITE LOGIC Report

Bio-Trap In-Situ Microcosm Study

Contact: Eric Smith
Address: Ramboll Environ
5 Park Plaza
Suite 500
Irvine, CA 92614

Phone: (949) 261-5151

Email: ESmith@Ramboll.com

MI Identifier:

036QE

Report Date: May 30, 2019

Project: Verdant Law-Vogel Paint, #1690001847-002

Comments:

NOTICE: This report is intended only for the addressee shown above and may contain confidential or privileged information. If the recipient of this material is not the intended recipient or if you have received this in error, please notify Microbial Insights, Inc. immediately. The data and other information in this report represent only the sample(s) analyzed and are rendered upon condition that it is not to be reproduced without approval from Microbial Insights, Inc. Thank you for your cooperation.

Executive Summary

A Bio-Trap® *In Situ* Microcosm (ISM) study was performed in wells GMW7R, GMW13, and TC-6D to investigate the potential for enhanced bioremediation of BTEX hydrocarbons under conditions of biostimulation (oxygen addition) or bioaugmentation. For each well in this monitoring event, the ISM assembly consisted of four Bio-Trap units: (i) a control MNA unit containing no exogenous amendment; (ii) a BioStim unit amended with EOx™ (calcium peroxide) for slow, controlled release of oxygen; (iii) a BioStim unit amended with EOx and diammonium phosphate (DAP); and (iv) a BioAug unit amended with bacterial culture BAC-TPH. Pre-deployment analysis of the BAC-TPH culture indicated the presence of a high concentration of the phenol hydroxylase (PHE) gene. Following an in-well deployment period of 44 days, the ISM units were recovered for CENSUS® quantification of total eubacteria, as well as specific functional genes encoding ethylbenzene dioxygenase (EDO) and PHE. Concentrations of BTEX contaminants and anions are also provided. A summary of the results is presented in Tables 1 - 3 and Figures 1 - 3. Key observations from the results obtained for each *in situ* microcosm are described below.

GMW7R Bio-Trap Units

- CENSUS® analysis indicated that biomass (EBAC) levels increased by an order of magnitude to 10^8 cells/bead each under EOx amendment and bioaugmentation with BAC-TPH compared to conditions of monitored natural attenuation (MNA, 10^7 cells/bead). These results suggest the *in-situ* survival of the BAC-TPH culture during the deployment period.
- EBAC concentrations in the BioStim unit amended with EOx and DAP were similar to those measured in the MNA unit, indicating no further enhancement of indigenous bacterial growth under conditions of EOx+DAP addition.
- No concentration enhancement was observed for genes encoding ethylbenzene dioxygenase (EDO) under either biostimulation or bioaugmentation conditions at well GMW7R. EDO levels actually decreased by three orders of magnitude under amendment with EOx+DAP and BAC-TPH relative to MNA conditions. Ethylbenzene dioxygenases are aromatic oxygenases that catalyze the aerobic biodegradation of alkylbenzenes including ethylbenzene and isopropylbenzene.
- CENSUS® analysis indicated that the concentration of PHE increased over MNA levels by an order of magnitude to 10^5 cells/bead under EOx amendment, but not under EOx+DAP amendment. In addition, the PHE concentration was three orders of magnitude higher in the BioAug unit deployed in well GMW7R compared to the MNA unit, indicating that higher PHE concentrations were maintained during the 44-day deployment period. Phenol hydroxylase enzymes mediate the continued oxidation of phenols produced by ring-hydroxylating monooxygenases. These CENSUS® results indicate an enhanced genetic potential for aerobic BTEX biodegradation during the deployment period under conditions of EOx amendment and bioaugmentation.
- Contaminant analysis indicated that xylenes were the primary hydrocarbons present in the Bio-Trap units deployed in well GMW7R; however, in general, total xylene concentrations were below the practical quantitation limit in all of the Bio-Trap units except for the BioStim-EOx unit, which contained 252 µg/L of total xylenes. The contaminant data suggested the possibility of vertical heterogeneity in the subsurface distribution of BTEX hydrocarbons.

GMW13 Bio-Trap Units

- For the bio-trap assembly deployed in GMW13, the concentration of total bacteria (EBAC) increased one order of magnitude to 10^8 cells/bead relative to the MNA unit (10^7 cells/bead) under EOx+DAP amendment and BAC-TPH bioaugmentation. However, total biomass levels were three orders of magnitude lower under EOx amendment alone compared to MNA conditions.

- EDO and PHE gene levels showed no enhancement under biostimulation with EOx, but actually decreased three orders of magnitude compared to MNA conditions during the deployment period.
- The EDO concentration increased an order of magnitude under EOx+DAP amendment (10^6 cells/bead) compared to MNA conditions (10^5 cells/bead), indicating an enhanced genetic potential for the aerobic biodegradation of ethylbenzene at this well site. However, the PHE concentration in the BioStim-EOx+DAP unit was similar to levels detected in the MNA unit, suggesting no enhanced genetic potential for aerobic BTEX biodegradation under EOx+DAP amendment.
- The degradative functional gene PHE was detected at a high concentration of 10^7 cells/bead in the BioAug unit deployed in well GMW13. This PHE level was two orders of magnitude higher over the concentration observed in the MNA unit, suggesting the *in-situ* survival of exogenous aerobic BTEX degraders during the deployment period. However, no enhancement of EDO levels was observed under conditions of bioaugmentation.
- Contaminant analysis indicated that xylenes (total) and ethylbenzene were the primary hydrocarbons present in the ISM Bio-Trap units deployed in well GMW13. Concentrations of these contaminants were substantially lower in the units amended with EOx, EOx+DAP, and BAC-TPH compared to the MNA unit. In addition, toluene levels were lower in all of the amended Bio-Trap units compared to the MNA unit. These results suggest that aerobic biodegradation of ethylbenzene and BTEX hydrocarbons was enhanced in the presence of slow-release oxygen compounds and BAC-TPH during the 44-day deployment period.

TC-6D Bio-Trap Units

- CENSUS® analysis indicated that levels of total bacteria (EBAC) were not substantially enhanced under oxygen amendment or under bioaugmentation with BAC-TPH compared to MNA conditions.
- EDO concentrations decreased by two orders of magnitude under EOx, EOx+DAP, and BAC-TPH conditions relative to the MNA unit, indicating that neither biostimulation nor bioaugmentation enhanced the genetic potential for aerobic bioremediation of ethylbenzene contaminants via this pathway.
- The genetic potential for the aerobic biodegradation of BTEX was markedly enhanced under bioaugmentation conditions as demonstrated by the increase in PHE levels (*i.e.*, 10^7 cells/mL) by two orders of magnitude over that observed in the MNA unit (*i.e.*, 10^5 cells/mL).
- BTEX contaminants were below the detection limit in the BioStim-EOx unit, whereas ethylbenzene (589 µg/L) and total xylenes (1,930 µg/L) were higher in the BAC-TPH BioAug unit compared to the other ISM Bio-Trap units deployed in well TC-6D. Contaminant results suggest that there may be vertical heterogeneity in the subsurface distribution of contaminants.

Overview of Approach

Site managers have frequently turned to laboratory microcosms or small pilot studies to evaluate bioremediation. However, duplication of *in situ* conditions in the laboratory is difficult and the results often do not correlate to the field. Pilot studies are performed in the field but are often prohibitively expensive as an investigative tool. Bio-Trap studies serve as cost-effective, *in situ* microcosms providing microbial, chemical, and geochemical evidence to evaluate biodegradation as a treatment mechanism and to screen remedial alternatives.

Typically each Bio-Trap Unit will contain samplers to evaluate the following:

Geochemical Fingerprint (GEO)	•20 mL amber VOA vial with a nylon screened cap designed for assessment of a variety of geochemical parameters including anions and metabolic acids.
Contaminant of Concern (COC)	•40 mL amber VOA vial with a low density polyethylene (LDPE) seal designed for analysis of a variety of COCs including chlorinated solvents and petroleum hydrocarbons.
Microbial Populations (MICRO)	•PVC cassette containing Bio-Sep beads which provide a large surface area for microbial attachment and were designed for analysis by a variety of molecular biological tools (MBTs).

How does it work?

The MICRO sampler (microbial populations) contains Bio-Sep® beads, an engineered composite of Nomex® and powdered activated carbon which provides an incredibly large surface area (~600 m²/g) that is readily colonized by subsurface microorganisms. In addition to a matrix for microbial growth, the Bio-Sep® beads can be “baited” with amendments including electron donors (e.g. hydrogen releasing compounds) to investigate biostimulation approaches to enhance biodegradation. The Bio-Trap units also contain a COC (contaminant of concern) sampler to measure contaminant concentrations, daughter product formation, and dissolved gases and a GEO (geochemical fingerprint) sampler for quantification of geochemical parameters (nitrate, iron, sulfate, etc.), chloride production and metabolic acids (pyruvic, lactic, acetic, propionic, etc.).

Bio-Trap® *In Situ* Microcosm studies at chlorinated solvent sites typically include three types of Bio-Trap Units deployed within a monitoring well. Each Bio-Trap Unit corresponds to one of the three most common remedial options: monitored natural attenuation (MNA), Biostimulation (BioStim), and Bioaugmentation (BioAug). All three Bio-Trap Units contain COC and GEO samplers for chemical and geochemical analyses. The key difference between the Bio-Trap Units is in the MICRO sampler.

Types of Bio-Trap Units typically deployed and MICRO sampler configurations:

Control (MNA)	•Bio-Sep® beads contain no additional electron donor and represent current aquifer conditions.
Biostimulation (BioStim)	•Bio-Sep® beads are baited with a specified electron donor (sodium lactate, EOS, HRC, molasses, etc) or an Amendment Supplier is used to release the desired amendment.
Bioaugmentation (BioAug)	•Bio-Sep® beads are pre-inoculated with a <i>Dehalococcoides</i> culture. These units can also be baited with an additional electron donor.

MNA Unit: The purpose of the Control Bio-Trap Unit is to quantify contaminant degrading bacteria and daughter product formation under monitored natural attenuation (MNA) conditions and to serve as a baseline for comparison to BioStim and/or BioAug Units.

Following in-well deployment, DNA or phospholipid fatty acids can be extracted from the Bio-Sep beads for CENSUS or PLFA analyses. For example, DNA extracted from the Bio-Sep beads can be used in CENSUS analysis of *Dehalococcoides* (qDHC) and vinyl chloride reductase (qVC) genes to evaluate the potential for complete reductive dechlorination of PCE to ethene under MNA conditions. The VOC and anion samplers can be used to determine concentrations of contaminants, daughter products, dissolved gases, terminal electron acceptors, and chloride.

BioStim Unit: The Biostimulation Bio-Trap Unit is designed to test the hypothesis that electron donor addition will stimulate growth of dechlorinating bacteria and enhance biodegradation. As with the MNA Unit, the BioStim Unit contains COC and GEO samplers for chemical analyses. The BioStim Unit may contain either a MICRO sampler that contains Bio-Sep beads “baited” with the specified electron donor or an amendment supplier to release the desired amendment over the incubation time. If an Amendment Supplier is used the MICRO sampler will contain standard Bio-Sep beads for the growth matrix.

BioAug Unit: The Bioaugmentation Bio-Trap Unit is designed to evaluate bioaugmentation as a treatment technology. The MICRO sampler contains Bio-Sep beads pre-inoculated with the desired commercial culture and also contains an electron donor of choice. As with the MNA and BioStim Units, the BioAug Unit also contains a COC and GEO samplers for chemical analyses.

Results

Table 1. Summary of the results obtained for *In Situ* Microcosm Units.

Sample Information	GMW7R MNA	GMW7R Bio-Stim EOx	GMW7R Bio-Stim EOx+DAP	GMW7R BAC-TPH BioAug
Treatment	MNA	BioStim	BioStim	BioAug
Sample Date	5/9/2019	5/9/2019	5/9/2019	5/9/2019
MI ID	036QE-1	036QE-2	036QE-3	036QE-4
Microbial Populations (cells/bd)				
Total Eubacteria (EBAC)	4.16E+07	2.73E+08	6.42E+07	3.71E+08
Ethylbenzene dioxygenase (EDO)	3.45E+05	2.25E+05	4.90E+02	7.09E+02
Phenol Hydroxylase (PHE)	7.02E+04	1.93E+05	6.03E+04	2.47E+07
Contaminant of Concern (µg/L) ¹				
Benzene	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	<1.0	<1.0	<1.0	0.5 (J)
Toluene	<1.0	<1.0	<1.0	<1.0
Xylenes, Total	2.5 (J)	251	<3.0	1.6 (J)
Anions (mg/L)				
Chloride	31	6.0 (J)	22.2	31
Nitrate	<0.1	<1.0	<0.1	<0.1
Nitrite	<0.1	<1.0	<0.1	<0.1
Sulfate	103	7.8 (J)	74.8	100
OrthoPhosphate	0.29	0.06 (J)	0.06 (J)	0.20

Legend: NA = Not analyzed NS = Not sampled J = Estimated result below PQL but above LQL I = Inhibited <= Result not detected.

¹Headspace in the Contaminant of Concern VOA vials submitted for GMW7R MNA, GMW7R Bio-Stim EOx, GMW7R BAC-TPH BioAug

Table 2. Summary of the results obtained for *In Situ* Microcosm Units.

Sample Information	GMW13 MNA	GMW13 Bio-Stim EO _x	GMW13 Bio-Stim EO _x +DAP	GMW13 BAC- TPH BioAug
Treatment	MNA	BioStim	BioStim	BioAug
Sample Date	5/9/2019	5/9/2019	5/9/2019	5/9/2019
MI ID	036QE-5	036QE-6	036QE-7	036QE-8
Microbial Populations (cells/bd)				
Total Eubacteria (EBAC)	6.89E+07	7.41E+04	1.33E+08	9.35E+08
Ethylbenzene dioxygenase (EDO)	2.71E+05	6.49E+02	1.29E+06	1.58E+04
Phenol Hydroxylase (PHE)	1.40E+05	8.20E+02	2.05E+05	4.66E+07
Contaminant of Concern (µg/L)				
Benzene	<25.0	1.3	<5.0	3.9 (J)
Ethylbenzene	15,600	387	1,700	10,100
Toluene	6,700	384	905	4,660
Xylenes, Total	72,400	1,680	17,400	37,700
Anions (mg/L)				
Chloride	13.3	15.3	22.4	31.7
Nitrate	<0.1	0.6 (J)	<0.1	<0.1
Nitrite	<0.1	<1.0	<0.1	<0.1
Sulfate	8.2	7.7 (J)	0.3 (J)	<5.0
OrthoPhosphate	<0.13	0.07 (J)	<0.13	0.23

Legend: NA = Not analyzed NS = Not sampled J = Estimated result below PQL but above LQL I = Inhibited <= Result not detected.

Table 3. Summary of the results obtained for *In Situ* Microcosm Units.

Sample Information	TC-6D MNA	TC-6D Bio-Stim EOx	TC-6D Bio-Stim EOx+DAP	TC-6D BAC-TPH BioAug
Treatment	MNA	BioStim	BioStim	BioAug
Sample Date	5/9/2019	5/9/2019	5/9/2019	5/9/2019
MI ID	036QE-9	036QE-10	036QE-11	036QE-12
Microbial Populations (cells/bd)				
Total Eubacteria (EBAC)	1.62E+08	5.50E+08	7.24E+07	6.57E+08
Ethylbenzene dioxygenase (EDO)	1.58E+05	5.93E+03	1.36E+03	4.30E+03
Phenol Hydroxylase (PHE)	3.87E+05	8.74E+05	1.41E+05	4.35E+07
Contaminant of Concern (µg/L) ¹				
Benzene	0.6 (J)	<1.0	<1.0	<100
Ethylbenzene	87.2	<1.0	28.3	589
Toluene	<10.0	<1.0	<1.0	<100
Xylenes, Total	108	<3.0	171	1,930
Anions (mg/L)				
Chloride	21.2	6.2 (J)	0.8 (J)	22.9
Nitrate	<0.1	<1.0	<1.0	<0.1
Nitrite	<0.1	<1.0	<1.0	<0.1
Sulfate	8.8	3.6 (J)	0.8 (J)	0.7 (J)
OrthoPhosphate	<0.13	<0.13	0.08 (J)	0.87

Legend: NA = Not analyzed NS = Not sampled J = Estimated result below PQL but above LQL I = Inhibited <= Result not detected.

¹ Headspace in the Contaminant of Concern VOA vials submitted for TC-6D BioStim EOx+DAP

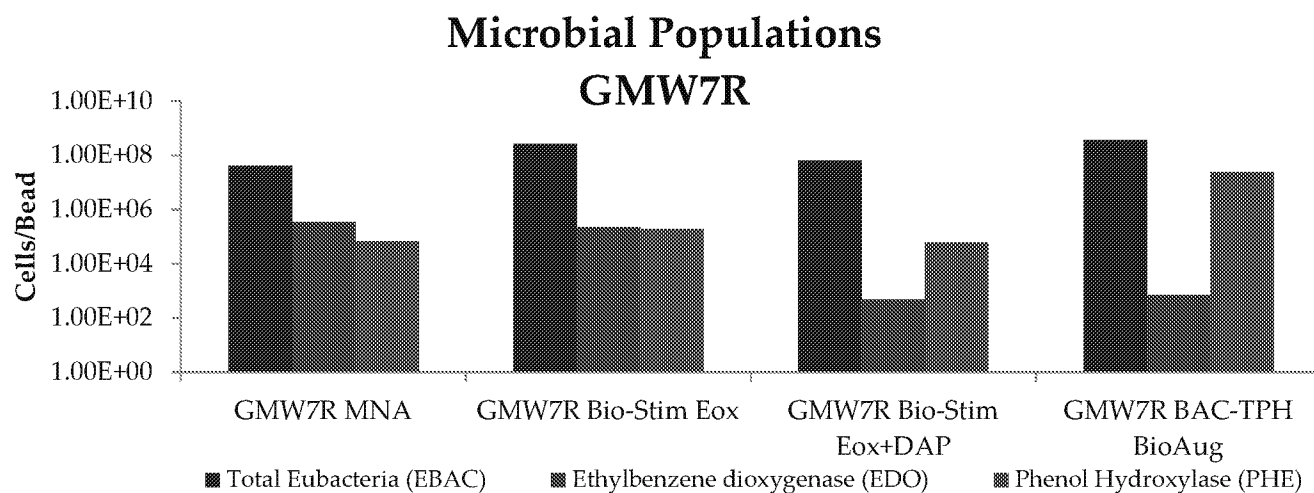


Figure 1. CENSUS® results for selected microbial populations (cells/bead) for Bio-Trap units deployed in GMW7R.

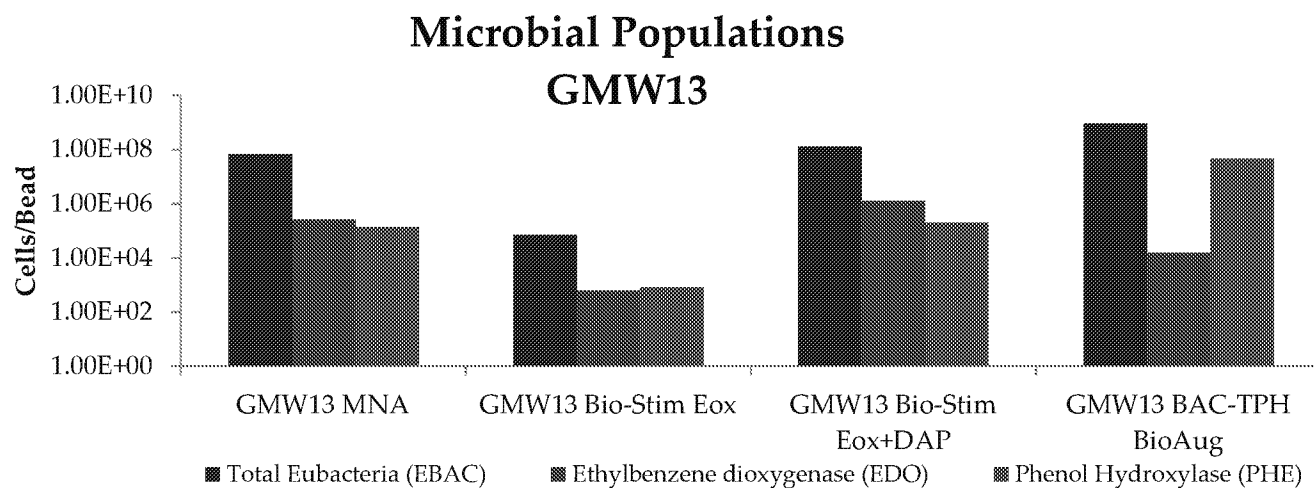


Figure 2. CENSUS® results for selected microbial populations (cells/bead) for Bio-Trap units deployed in GMW13.

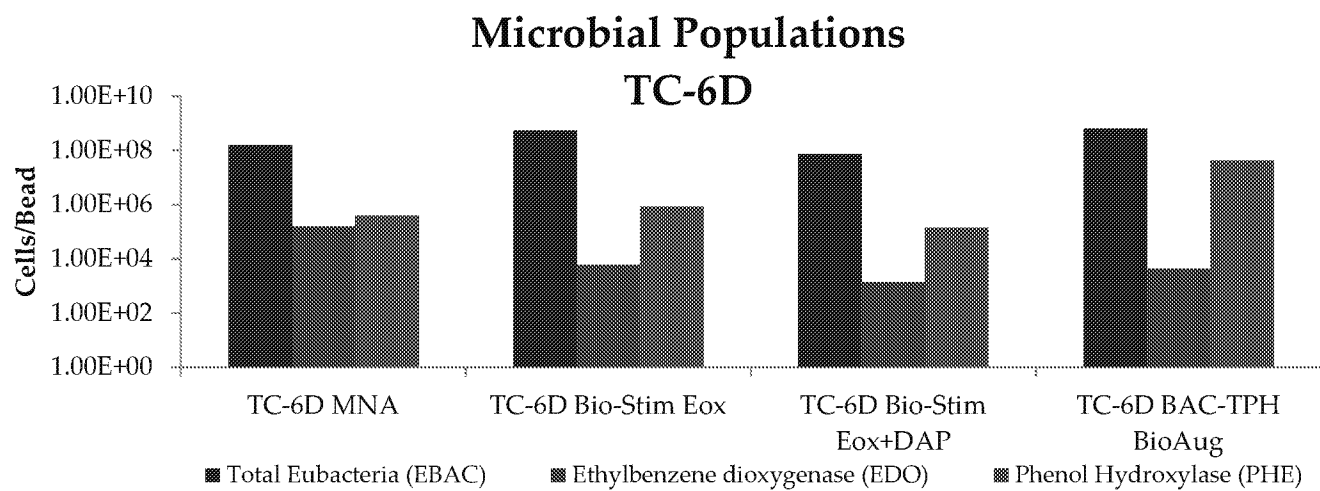


Figure 3. CENSUS® results for selected microbial populations (cells/bead) for Bio-Trap units deployed in TC-6D.

Glossary

Amendment Supplier: a component that fits inside the MICRO-Trac/Bio-Trap unit at the bottom. This component is designed to slowly diffuse a desired amendment within a BioStim and/or a BioAug Unit during the incubation time.

Sampler: Individual components consisting either of a geochemical (GEO), contaminant of concern (COC) or microbial (MICRO) sampler. Geochemical samplers are essentially VOA vials with special septa that facilitate transfer. The microbial samplers are made from a smaller PVC pipe ~1" x 3 1/2" and contains Bio-Sep® beads which serve as a microbial growth matrix.

COC Sampler: 40 mL amber VOA with a low density polyethylene membrane permitting passive diffusion of volatile organic compounds (VOCs).

GEO Sampler: a 20 mL amber VOA with a nylon based membrane permitting passive diffusion of anionic species.

MICRO Sampler: a polyvinylchloride cassette containing Bio-Sep® beads which provide a large surface area for microbial growth. In addition to a matrix for microbial growth, the Bio-Sep® beads can be "baited" with amendments including ¹³C labeled chlorobenzene as used in this study. Bio-Sep® beads were designed to allow extraction of phospholipids fatty acids and DNA for analysis of microbial communities.

Unit: 1.25" x 15" PVC housing that all of the samplers are place into for deployment. Units will have baffled end caps to separate different zones within the monitoring well. Typically each unit will correspond to a treatment approach.

Assembly: Collections of Units for a particular monitoring well. Samplers (GEO, COC, and MICRO) are placed in each unit. Units are linked to form an Assembly. An entire Assembly (consisting of multiple units) is deployed in each well.

CENSUS: CENSUS is based on a technique called quantitative polymerase chain reaction (qPCR) whereby many copies of a specific gene are generated. As each gene copy is made, a fluorescent marker is released, measured, and used to quantify the number of target genes present in a sample.

APPENDIX B
AMENDMENT AND REAGENT TECHNICAL DATA AND SDS'S

EO_x

Granular powder of calcium peroxide that provides slow, steady oxygen supply for long-term aerobic biodegradation



Steady, long-term supply of oxygen to speed up site closure with enhanced aerobic biodegradation of BTEX, PAHs, DRO, MTBE, VC and other complex contaminants

Product Advantages

- 17% by weight oxygen
- Most cost effective oxygen releasing product available
- Slowly releases oxygen; ≥ 1 yr of treatment
- Effective for non-chlorinated hydrocarbons
- Increases pH
- Ideal for UST excavations

EOS
EOS Remediation



**Experience you can rely on,
Products you can trust™**

Description

EO_x is an established *in situ* technology that enhances the aerobic biodegradation of a wide range of contaminants.

EO_x benefits:

- Slowly releases oxygen (typically between 9-12 months) to aid long-term aerobic biodegradation
- Lowest cost calcium peroxide on the market
- Powdered material with no inert fillers
- Increases pH
- Effective for a wide range of hydrocarbons, including BTEX and PAHs

EO_x applications:

- Excavations: Evenly disperse powder in the base of excavations and add water to saturate the subgrade and backfill.
- Direct Injection: Mix powder with water (4 parts water: 1 part EO_x) and inject through conventional wells or direct push rods.

Chemical & Physical Properties

<u>Electron Acceptor:</u> EO _x	<u>Typical</u>
Calcium Peroxide (% by wt.)	75
Calcium Hydroxide (% by wt.)	25
Available oxygen (%)	17
Bulk Density	~550 g/L or 34.3 lbs/ft ³
pH (Standard Units)	12
Electron acceptor equivalents per lb.	9.5 O ₂ ⁻ eq./lbs
Appearance	white or yellowish powder
Particle size distribution	<74 micron (99% passes 200 mesh)

Packaging



Shipped in 30-gallon drums as Hazard Class 5.1 (oxidizer) under International Packing Group II, 30-gallon unrated poly drums, or 50lb bags (minimum order required).

Handling & Storage

EO_x should be stored inside away from combustibles and protected from moisture. Once opened, do not return removed material to the original container.

SAFETY DATA SHEET

Section 1: Identification	
Product Name:	EOx
Chemical Description:	Mixture; solid white powder
Manufacturer:	EOS Remediation PO Box 14266 Research Triangle Park NC, 27709 (P): 919-873-2204
Recommended Use:	Groundwater and Soil Remediation (environmental applications)
Restricted Use:	Any use not specified by the manufacturer
24-Hour Emergency Contact:	ChemTel: United States (P): 800-255-3924 ChemTel: International (P): 813-248-0585

Section 2: Hazard(s) Identification	
Hazard Classification:	Oxidizer; Irritant (skin and eye)
Signal Word:	Danger
Hazard Statement(s):	Oxidizer; may decompose exothermically and ignite combustible material.
Pictograms:	 
Precautionary Statement(s):	Not for human consumption. Do not store near combustible material. Prevent contact with eyes and skin. Wear protective gloves and eye protection. Avoid aerosol generation.

Section 3: Composition/Information on Ingredients		
Chemical Name	CAS NO.	% by Weight
Calcium Peroxide	1305-79-9	75
Calcium Hydroxide	1305-62-0	25

Section 4: First-Aid Measures	
Routes of Exposure	Emergency First-Aid Procedures
Inhalation	Remove to fresh air; if breathing difficulty or discomfort persists seek medical attention
Eye Contact	Flush with water for 15 minutes and immediately seek medical attention
Skin Contact	Wash with mild soap and water; if irritation persists seek medical attention
Ingestion	Rinse mouth with water and dilute by consuming 1-2 glasses of water. Do not induce vomiting. Immediately seek medical attention

Section 5: Fire-Fighting Measures

Extinguishing Media:	CO2, foam or dry chemical appropriate for surrounding materials
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and chemical resistant clothing.
Fire Hazard(s):	Oxidizer; may decompose exothermically and ignite combustible material. Oxygen release during decomposition may support combustion.
Explosion Hazard(s):	Storage vessels in a fire may vent gas or rupture violently.

Section 6: Accidental Release Measures

Personal Precautions:	Avoid contact with eyes, skin and clothing. Do not breathe dusts. Wash hands and skin thoroughly after handling.
Emergency Procedures:	In event of fire, use large quantities of water and call the fire department. In case of a fire, all means of extinguishing are acceptable. Do not approach flames or hot vessels that contain this product.
Methods & Materials used for Containment:	Avoid using materials that will create excess dust. Wet with water spray and shovel into appropriate container, clean residue with dilute solution of acetic acid
Cleanup Procedures:	Shovel material into containers for disposal. Flush remaining area with water to remove trace residue and dispose of properly. Avoid discharge to sewers and surface waters; notify authorities if discharge occurs.

Section 7: Handling and Storage

Safe Handling & Storage:	Store in cool, dry, well-ventilated area away from all sources of heat and ignition. Keep out of direct sunlight and protect from moisture and incompatible materials.
Other Precautions:	Prevent contact with combustible or organic materials. Do not store in unlabeled or mislabeled containers. Keep containers well sealed. Consumption of food and beverages should be prevented in work area where product is being used. After handling product, always wash hands and face thoroughly with soap and water before eating, drinking, or smoking.

Section 8: Exposure Controls/Personal Protection**Exposure Limits**

OSHA PEL:	Dusts (as Calcium Hydroxide)	15 mg/m3 (total) 5 mg/m3 (respirable)
ACGIH TLV:	Dusts (as Calcium Hydroxide)	5 mg/m3
NIOSH REL:	Dusts (as Calcium Hydroxide)	5 mg/m3
Personal Protective Measures		
Respiratory Protection:	Not normally required; wear NIOSH approved particulate respirator where dusts are generated.	
Hand Protection:	Impervious protective gloves made of nitrile, natural rubber or neoprene	
Eye Protection:	Chemical safety goggles recommended	

Engineering Measures:	Use in a well-ventilated area; Avoid creating dust. Local exhaust ventilation if aerosols are generated
Hygiene Measures:	Wash promptly with soap & water if skin becomes irritated from contact.
Other Protection:	Wear appropriate clothing to prevent skin contact; have eye wash station located at site

Section 9: Physical and Chemical Properties

Appearance:	White powder	Explosive Limits:	NE
Odor:	None	Vapor Pressure:	NE
Odor Threshold:	N/A	Vapor Density:	1.18
pH:	N/A	Relative Density:	2.92
Melting Point/Freezing Point:	Decomposes @ 275°F (135°C)	Solubility:	Slightly soluble
Boiling Point:	N/A	Partition coefficient:	NE
Flash Point:	NE	Auto-ignition Temperature:	N/A
Evaporation Rate:	NE	Decomposition Temperature:	275°F (135°C)
Flammability (solid, gas):	NE	Viscosity:	N/A

NE – Not Established

N/A – Not Applicable

Section 10: Stability and Reactivity

Stability:	Stable under normal conditions
Incompatibility:	Water, acids, bases, salts of heavy metals, reducing agents, organic materials, flammable substances
Hazardous Decomposition Products:	Oxygen: supports combustion
Hazardous Reactions/Polymerization:	None Known
Conditions to Avoid:	Excessive heat, ignition sources

Section 11: Toxicological Information

Likely Routes of Exposure:	Inhalation, Ingestion, Dermal and Eye contact
Signs and Symptoms of Exposure:	Irritation of eyes, nose, throat, lungs, skin
Health Hazards	
Acute:	Potential eye, nose, throat, lung and skin irritant; eye contact may cause serious or permanent eye lesions; Ingestion may be irritating to throat and mouth causing nausea and vomiting.
Chronic:	None Known
Carcinogenicity	
NTP:	No
IARC:	No
OSHA:	No

Section 12: Ecological Information (non-mandatory)

There is no data on the ecotoxicity of this product.

Section 13: Disposal Considerations (non-mandatory)

Waste Disposal Methods: Dispose of according to Federal and local regulations for non-hazardous waste.

Section 14: Transport Information (non-mandatory)

UN Number: 1457	Transport Hazard Class: 5.1
UN Proper Shipping Name: Calcium Peroxide	Packing Group: II

Section 15: Regulatory Information (non-mandatory)

HMIS® Rating: Health – 2 , Reactivity – 1 , Flammability – 0, PPE – Required

NFPA® Rating: Health – 2 , Reactivity – 1 , Flammability – 0 , OX

Section 16: Other Information

Date of Preparation: 29 May 2014

Last Modified Date: 12 August 2019

The information contained herein is based on available data and is believed to be correct. However, EOS Remediation, LLC makes no warranty, expressed or implied, regarding the accuracy of this data or the results to be obtained thereof. This information and product are furnished on the condition that the person receiving them shall make his/her own determination as to the suitability of the product for his/her particular purpose.

Safety Data Sheet

**Section 1: Identification of the Substance/Mixture and of the Company/Undertaking****1.1 Product identifier**

Product Name	q Diammonium Phosphate
Synonyms	q Ammonium Phosphate, Dibasic; Ammonium Phosphate, Secondary; DAP
CAS Number	q 7783-28-0
SDS Number/Grade	q 31
EC Number	q 231-987-8
REACH Registration Number	q 01-2119490974-22-0057
Product Description	q White powder solid with ammonia-like odor.
Molecular Formula	q (NH ₄) ₂ HPO ₄
Molecular Weight	q 132.06

1.2 Relevant identified uses of the substance or mixture and uses advised against

Relevant identified use(s)	q Nutrient in manufacture of yeast; ingredient in compound bread improvers. Flame retardant. Agriculture - Ingredient in specialty all-soluble dry fertilizers. Building Materials - Flame-proofing of wood. Paint - Ingredient in flame-proofing of specialty paper; prevention of afterglow in matches. Pulp and Paper - Flame-proofing of specialty paper; prevention of afterglow in materials. Textile - Flame-proofing of fabrics and cotton batting. Nutrient feed for biological treatment plants.
-----------------------------------	--

1.3 Details of the supplier of the safety data sheet

Manufacturer	q Innophos 259 Prospect Plains Rd. Bldg A Cranbury, NJ 08512-3706 United States
Telephone (Technical)	q 609-495-2495
Responsible Party - EU	q LSR Associates Ltd Woolley Road Alconbury, Cambridgeshire PE28 4HS United Kingdom info@lsr-associates.com
Telephone (General)	q +44 (0) 1954 212132

1.4 Emergency telephone number

Manufacturer	q 800-424-9300 - Chemtrec - within USA and Canada
Manufacturer	q +1 703-527-3887 - Chemtrec - outside USA and Canada (collect calls accepted)
Manufacturer	q 615-386-7816 - Innophos Emergency Communication Team (ECT)

Section 2: Hazards Identification

EU/EEC

According to Regulation (EC) No 1272/2008 (CLP)/REACH 1907/2006 [amended by 453/2010]
According to EU Directive 67/548/EEC (DSD) or 1999/45/EC (DPD)

2.1 Classification of the substance or mixture

CLP _q Not classified

DSD/DPD _q Not classified

2.2 Label Elements

CLP
Hazard statements _q No label element(s) required.

DSD/DPD
Risk phrases _q No label element(s) required.

2.3 Other Hazards

CLP _q According to Regulation (EC) No. 1272/2008 (CLP) this material is not considered hazardous.

DSD/DPD _q This product is not considered dangerous under the European Directive 67/548/EEC

United States (US)

According to OSHA 29 CFR 1910.1200 HCS

2.1 Classification of the substance or mixture

OSHA HCS 2012 _q Not classified

2.2 Label elements

OSHA HCS 2012
Hazard statements _q No label element(s) required.

2.3 Other hazards

OSHA HCS 2012 _q This product is not considered hazardous under the U.S. OSHA 29 CFR 1910.1200 Hazard Communication Standard.

Canada

According to WHMIS

2.1 Classification of the substance or mixture

WHMIS _q Not classified

2.2 Label elements

WHMIS _q No label element(s) required.

2.3 Other hazards

WHMIS _q In Canada, the product mentioned above is not considered hazardous under the Workplace Hazardous Materials Information System (WHMIS)

Section 3 - Composition/Information on Ingredients**3.1 Substances**

Composition					
Chemical Name	Identifiers	%	LD50/LC50	Classifications According to Regulation/Directive	Comments
Phosphoric acid, ammonium salt (1:2)	CAS:7783-28-0 EC Number:231-987-8	100%	NDA	EU DSD/DPD: Not Classified EU CLP: Not Classified OSHA HCS 2012: Not Classified	NDA

3.2 Mixtures

- q Material does not meet the criteria of a mixture in accordance with Regulation (EC) No 1272/2008.

Section 4 - First Aid Measures

4.1 Description of first aid measures

Inhalation

- q Move victim to fresh air. Administer oxygen if breathing is difficult. Give artificial respiration if victim is not breathing. If signs/symptoms continue, get medical attention.

Skin

- q IF ON SKIN: Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse.

Eye

- q Flush eyes with water for at least 15 minutes while holding eyelids open. Remove contact lenses if worn. If eye irritation persists: Get medical advice/attention.

Ingestion

- q If swallowed, do NOT induce vomiting unless directed to do so by medical personnel. If swallowed give 2-3 glasses of water if victim is conscious and alert. Do not give anything by mouth to an unconscious person. Rinse mouth. Vomiting may occur spontaneously. To prevent aspiration of swallowed product, lay victim on side with head lower than waist. If vomiting occurs and the victim is conscious, give water to further dilute the chemical.

4.2 Most important symptoms and effects, both acute and delayed

- q Refer to Section 11 - Toxicological Information.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to Physician

- q All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

Section 5 - Firefighting Measures

5.1 Extinguishing media

Suitable Extinguishing Media q Not combustible. Use extinguishing media suitable for surrounding fire.

Unsuitable Extinguishing Media q None known.

5.2 Special hazards arising from the substance or mixture

Unusual Fire and Explosion Hazards q Non-combustible.

Hazardous Combustion Products q Ammonia
Oxides of nitrogen, oxides of phosphorus.

5.3 Advice for firefighters

- q Wear positive pressure self-contained breathing apparatus (SCBA).
Structural firefighters' protective clothing will only provide limited protection.
Move containers from fire area if you can do it without risk.

LARGE FIRES: Dike fire-control water for later disposal.
LARGE FIRES: Do not scatter spilled material with high pressure water streams.

Section 6 - Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures

- Personal Precautions** q Do not touch or walk through spilled material. Wear appropriate personal protective equipment, avoid direct contact.
- Emergency Procedures** q Ventilate closed spaces before entering. Keep unauthorized personnel away.

6.2 Environmental precautions

- q Runoff from fire control or dilution water may cause pollution. Prevent material from entering public sewer system or any waterways. Spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies.

6.3 Methods and material for containment and cleaning up

- Containment/Clean-up Measures** q Sweep or vacuum up and place in an appropriate closed container. Avoid generating dust. Clean up residual material by washing area with water and detergent. Collect washings for disposal.

6.4 Reference to other sections

- q Refer to Section 8 - Exposure Controls/Personal Protection and Section 13 - Disposal Considerations.

Section 7 - Handling and Storage

7.1 Precautions for safe handling

- Handling** q Keep containers closed when not in use. Avoid breathing dust. Avoid direct or prolonged contact with skin and eyes. Do not ingest. Do not use in areas without adequate ventilation. Wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics, or using the toilet.

7.2 Conditions for safe storage, including any incompatibilities

- Storage** q Store in a cool/low-temperature, well-ventilated, dry place. Store in a tightly closed container. Product is hygroscopic and tends to cake on storage.

7.3 Specific end use(s)

- q Refer to Section 1.2 - Relevant identified uses.

Section 8 - Exposure Controls/Personal Protection

8.1 Control parameters

- Exposure Limits/Guidelines** q No exposure limits were found for this product or any of its ingredients.

8.2 Exposure controls

- Engineering Measures/Controls** q Adequate ventilation systems as needed to control concentrations of airborne contaminants below applicable threshold limit values.

Personal Protective Equipment

Respiratory

- q For limited exposure use an N95 dust mask. For prolonged exposure use an air-purifying respirator with high efficiency particulate air (HEPA) filters. Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or symptoms are experienced.

Eye/Face

- q Wear safety glasses.

Skin/Body

- q Wear appropriate gloves.

Environmental Exposure Controls

- q Follow best practice for site management and disposal of waste.

Section 9 - Physical and Chemical Properties**9.1 Information on Physical and Chemical Properties**

Material Description			
Physical Form	Solid	Appearance/Description	White powder solid with ammonia-like odor.
Color	White	Odor	Ammonia-like
Odor Threshold	Data lacking		
General Properties			
Boiling Point	Data lacking	Melting Point	Data lacking
Decomposition Temperature	Data lacking	pH	8
Specific Gravity/Relative Density	Data lacking	Water Solubility	Soluble 41 %
Viscosity	Data lacking	Explosive Properties	Not relevant.
Oxidizing Properties:	Not relevant.		
Volatility			
Vapor Pressure	Data lacking	Vapor Density	Data lacking
Evaporation Rate	Data lacking		
Flammability			
Flash Point	Data lacking	UEL	Data lacking
LEL	Data lacking	Autoignition	Data lacking
Flammability (solid, gas)	Not relevant.		
Environmental			
Octanol/Water Partition coefficient	Data lacking		

9.2 Other Information

- q No additional physical and chemical parameters noted.

Section 10: Stability and Reactivity**10.1 Reactivity**

- q No dangerous reaction known under conditions of normal use.

10.2 Chemical stability

- q Stable under normal temperatures and pressures.

10.3 Possibility of hazardous reactions

- q Hazardous polymerization will not occur.

10.4 Conditions to avoid

- q Dusting conditions, extreme heat, extreme humidity.

10.5 Incompatible materials

- q Strong bases, strong oxidizing agents. Sodium hypochlorite.

10.6 Hazardous decomposition products

- q Ammonia Oxides of nitrogen. Phosphoric acid. Oxides of phosphorus.

Section 11 - Toxicological Information

11.1 Information on toxicological effects

Diammonium Phosphate 7783-28-0								
Test Type	Dosage	Route	Species	Duration	Results	Test Class	Target Organs	Comments
Irritation		Skin	Rabbit	NDA	NDA	Mild irritation	NDA	NDA
Acute Toxicity	> 1000 mg/kg	Ingestion/Oral	Rat	NDA	LD50	NDA	NDA	NDA
GHS Properties				Classification				
Acute toxicity				EU/CLP • Data lacking OSHA HCS 2012 • Acute Toxicity - Data lacking				
Aspiration Hazard				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
Carcinogenicity				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
Germ Cell Mutagenicity				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
Skin corrosion/Irritation				EU/CLP • Data lacking OSHA HCS 2012 • Inconclusive data				
Skin sensitization				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
STOT-RE				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
STOT-SE				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
Toxicity for Reproduction				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
Respiratory sensitization				EU/CLP • Data lacking OSHA HCS 2012 • Data lacking				
Serious eye damage/Irritation				EU/CLP • Data lacking OSHA HCS 2012 • Inconclusive data				

Route(s) of entry/exposure ^q Inhalation, Skin, Eye, Ingestion

Potential Health Effects

Inhalation

Acute (Immediate) ^q May cause respiratory irritation.

Chronic (Delayed) ^q No data available.

Skin

Acute (Immediate) ^q May cause irritation.

Chronic (Delayed) ^q No data available.

Eye

Acute (Immediate) ^q May cause irritation.

Chronic (Delayed) ^q No data available.

Ingestion

Acute (Immediate) ^q Low acute oral toxicity. Ingestion of large quantities may cause abdominal pain, abdominal cramps, nausea, vomiting, diarrhea.

Chronic (Delayed) ^q No data available.

Carcinogenic Effects

- q This product does not contain any ingredient designated by IARC, NTP, ACGIH or OSHA as probable or suspected human carcinogens.

Key to abbreviations

LD = Lethal Dose

Section 12 - Ecological Information

12.1 Toxicity

Diammonium Phosphate			7783-28-0		
Dosage	Species	Duration	Results	Exposure Conditions	Comments
= 155 mg/L	Fish: Pimephales promelas	96 Hour(s)	LC50	NDA	NDA

12.2 Persistence and degradability

- q No data found for product.

12.3 Bioaccumulative potential

- q No data found for product.

12.4 Mobility in Soil

- q No data found for product.

12.5 Results of PBT and vPvB assessment

- q PBT and vPvB assessment has not been carried out.

12.6 Other adverse effects**Ecological Fate**

- q No data found for product.

Section 13 - Disposal Considerations

13.1 Waste treatment methods**Product waste**

- q Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

Packaging waste

- q Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

Section 14 - Transport Information

	14.1 UN number	14.2 UN proper shipping name	14.3 Transport hazard class(es)	14.4 Packing group	14.5 Environmental hazards
DOT	NDA	Not Regulated	NDA	NDA	NDA
TDG	NDA	Not Regulated	NDA	NDA	NDA
IMO/IMDG	NDA	Not Regulated	NDA	NDA	NDA
IATA/ICAO	NDA	Not Regulated	NDA	NDA	NDA

14.6 Special precautions for user

- q None known.

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

- q Not relevant.

Section 15 - Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

SARA Hazard Classifications q Acute

Inventory						
Component	CAS	Canada DSL	Canada NDSL	China	EU EINECS	EU ELNICS
Phosphoric acid, ammonium salt (1:2)	7783-28-0	Yes	No	Yes	Yes	No

Inventory (Con't.)				
Component	CAS	New Zealand	Philippines PICCS	TSCA
Phosphoric acid, ammonium salt (1:2)	7783-28-0	Yes	Yes	Yes

Canada

Labor

Canada - WHMIS - Classifications of Substances

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Canada - WHMIS - Ingredient Disclosure List

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Environment

Canada - 2004 NPRI (National Pollutant Release Inventory)

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Canada - 2005 NPRI (National Pollutant Release Inventory)

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Canada - CEPA - Greenhouse Gases Subject to Mandatory Reporting

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Canada - CEPA - Priority Substances List

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Canada - DWQ (Drinking Water Quality) - IMACs

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Other

Canada - Accelerated Reduction/Elimination of Toxics (ARET)

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Canada New Brunswick

Environment

Canada - New Brunswick - Ozone Depleting Substances - Schedule A

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

Canada - New Brunswick - Ozone Depleting Substances - Schedule B

• Phosphoric acid, ammonium salt (1:2) 7783-28-0 Not Listed

China

Other

China - Classification and Labeling of Dangerous Chemical Substances Commonly Used

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

Germany

Environment

Germany - TA Luft - Types and Classes

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

Germany - Water Classification (VwVwS) - Annex 1

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

Germany - Water Classification (VwVwS) - Annex 2 - Water Hazard Classes

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

Germany - Water Classification (VwVwS) - Annex 3

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	ID Number 7150, hazard class 1 - low hazard to waters
--	-----------	---

Philippines

Other

Philippines - Priority Chemical List

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

Singapore

Other

Singapore - Corrosive and Explosive Substances - Corrosive Substances

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

United States

Labor

U.S. - OSHA - Process Safety Management - Highly Hazardous Chemicals

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

U.S. - OSHA - Specifically Regulated Chemicals

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

Environment

U.S. - CAA (Clean Air Act) - 1990 Hazardous Air Pollutants

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

U.S. - CAA (Clean Air Act) - Class II Ozone Depletors

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

U.S. - CERCLA/SARA - Hazardous Substances and their Reportable Quantities

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

U.S. - CERCLA/SARA - Radionuclides and Their Reportable Quantities

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
--	-----------	------------

U.S. - CERCLA/SARA - Section 302 Extremely Hazardous Substances EPCRA RQs

• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - CERCLA/SARA - Section 302 Extremely Hazardous Substances TPQs		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - CERCLA/SARA - Section 313 - Emission Reporting		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - CERCLA/SARA - Section 313 - PBT Chemical Listing		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed

United States - California

Environment

U.S. - California - Proposition 65 - Carcinogens List		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - California - Proposition 65 - Developmental Toxicity		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - California - Proposition 65 - Maximum Allowable Dose Levels (MADL)		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - California - Proposition 65 - No Significant Risk Levels (NSRL)		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - California - Proposition 65 - Reproductive Toxicity - Female		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed
U.S. - California - Proposition 65 - Reproductive Toxicity - Male		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed

Vietnam

Environment

Vietnam - Industrial Wastewater Discharge Standards - Specific Permitted Water Bodies		
• Phosphoric acid, ammonium salt (1:2)	7783-28-0	Not Listed

15.2 Chemical Safety Assessment

q No Chemical Safety Assessment has been carried out.

Section 16 - Other Information

Last Revision Date	q 07/March/2014
Preparation Date	q 13/August/2004
Disclaimer/Statement of Liability	q The information herein is given in good faith but no warranty, expressed or implied, is made.
Key to abbreviations	
NDA = No Data Available	

1. Identification

Product identifier	PlumeSTOP®
Other means of identification	None.
Recommended use	Soil and Groundwater Remediation.
Recommended restrictions	None known.
Manufacturer/Importer/Supplier/Distributor information	
Company Name	RegenesiS
Address	1011 Calle Sombra San Clemente, CA 92673
Telephone	949-366-8000
E-mail	CustomerService@regenesiS.com
Emergency phone number	CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards	Not classified.
Health hazards	Not classified.
OSHA defined hazards	Not classified.
Label elements	
Hazard symbol	None.
Signal word	None.
Hazard statement	The mixture does not meet the criteria for classification.
Precautionary statement	
Prevention	Observe good industrial hygiene practices.
Response	Wash hands after handling.
Storage	Store away from incompatible materials.
Disposal	Dispose of waste and residues in accordance with local authority requirements.
Hazard(s) not otherwise classified (HNOC)	None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Water	7732-18-5	>75
Colloidal activated carbon ≤2.5 µm	7440-44-0	<25
Proprietary additives		≤2

Composition comments	All concentrations are in percent by weight unless otherwise indicated.
-----------------------------	---

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Direct contact with eyes may cause temporary irritation.

Indication of immediate medical attention and special treatment needed

Treat symptomatically.

General information

If you feel unwell, seek medical advice (show the label where possible). Show this safety data sheet to the doctor in attendance.

5. Fire-fighting measures

Suitable extinguishing media

Carbon dioxide, alcohol-resistant foam, dry chemical, water spray, or water fog.

Unsuitable extinguishing media

None known.

Specific hazards arising from the chemical

During fire, gases hazardous to health may be formed. Combustion products may include: carbon monoxide, carbon dioxide, sodium oxides, metal oxides.

Special protective equipment and precautions for firefighters

Use protective equipment appropriate for surrounding materials.

Fire fighting equipment/instructions

Move containers from fire area if you can do so without risk.

Specific methods

Use standard firefighting procedures and consider the hazards of other involved materials. Use water spray to keep fire-exposed containers cool.

General fire hazards

This material will not burn until the water has evaporated. Residue can burn. When dry may form combustible dust concentrations in air.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Keep unnecessary personnel away. Avoid contact with spilled material. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up

This product is miscible in water.

Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Environmental precautions

Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling

Avoid contact with skin and eyes. Avoid prolonged exposure. Observe good industrial hygiene practices. Wash thoroughly after handling. Wear appropriate personal protective equipment (See Section 8).

Conditions for safe storage, including any incompatibilities

Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Protect from freezing.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-3 (29 CFR 1910.1000)

Components	Type	Value	Form
Colloidal activated carbon ≤2.5 µm (CAS 7440-44-0)	TWA	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value	Form
Colloidal activated carbon ≤2.5 µm (CAS 7440-44-0)	TWA	2.5 mg/m3	Respirable.

Biological limit values

No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls

Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear approved chemical safety goggles.
Skin protection	
Hand protection	Rubber, neoprene or PVC gloves are recommended. Wash hands after handling.
Other	Avoid contact with the skin. Wear suitable protective clothing.
Respiratory protection	Not normally needed. In case of insufficient ventilation, wear suitable respiratory equipment. If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties**Appearance**

Physical state	Liquid.
Form	Aqueous suspension.
Color	Black.
Odor	Odorless.
Odor threshold	Not available.
pH	8 - 10
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	Not flammable.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.

Upper/lower flammability or explosive limits

Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.

Vapor pressure	Not available.
Vapor density	Not available.
Relative density	1 - 1.2

Solubility(ies)

Solubility (water)	Miscible
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials. Keep from freezing.
Incompatible materials	Strong oxidizing agents. Water reactive materials.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Prolonged inhalation may be harmful.
Skin contact	Prolonged or repeated skin contact may result in minor irritation.
Eye contact	Direct contact with eyes may cause temporary irritation.
Ingestion	Expected to be a low ingestion hazard.

Symptoms related to the physical, chemical and toxicological characteristics
Direct contact with eyes may cause temporary irritation.

Information on toxicological effects

Acute toxicity Not expected to be acutely toxic.

Components	Species	Test Results
Colloidal activated carbon $\leq 2.5 \mu\text{m}$ (CAS 7440-44-0)		
Acute		
<i>Inhalation</i>		
LC50	Rat	> 8500 mg/m ³ , air
<i>Oral</i>		
LD50	Rat	> 2000 mg/kg, (Female)

Skin corrosion/irritation Prolonged skin contact may cause temporary irritation.

Serious eye damage/eye irritation Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

Chronic effects Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential No data available.

Mobility in soil Expected to be temporarily highly mobile in soil.

Other adverse effects None known.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not established.

15. Regulatory information

US federal regulations All components are listed on or exempt from the U.S. EPA TSCA Inventory List. This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - No
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical No

SARA 313 (TRI reporting)
Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations

US. Massachusetts RTK - Substance List

Not regulated.

US. New Jersey Worker and Community Right-to-Know Act

Colloidal activated carbon $\leq 2.5 \mu\text{m}$ (CAS 7440-44-0)

US. Pennsylvania Worker and Community Right-to-Know Law

Not listed.

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

Not Listed.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).

A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 26-February-2015

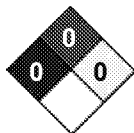
Revision date -

Version # 01

Further information HMIS® is a registered trade and service mark of the American Coatings Association (ACA).

HMIS® ratings Health: 0
Flammability: 0
Physical hazard: 0

NFPA ratings

**Disclaimer**

Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

1. Identification

Product identifier	PlumeSTOP® Nutrients
Other means of identification	None.
Recommended use	Soil and Groundwater Remediation.
Recommended restrictions	None known.
Manufacturer/Importer/Supplier/Distributor information	
Company Name	RegenesiS
Address	1011 Calle Sombra San Clemente, CA 92673
Telephone	949-366-8000
E-mail	CustomerService@regenesiS.com
Emergency phone number	CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards	Not classified.
Health hazards	Not classified.
OSHA defined hazards	Not classified.
Label elements	
Hazard symbol	None.
Signal word	None.
Hazard statement	The mixture does not meet the criteria for classification.
Precautionary statement	
Prevention	Observe good industrial hygiene practices.
Response	Wash hands after handling.
Storage	Store away from incompatible materials.
Disposal	Dispose of waste and residues in accordance with local authority requirements.
Hazard(s) not otherwise classified (HNOC)	None known.
Supplemental information	None.

3. Composition/information on ingredients**Mixtures**

The manufacturer lists no ingredients as hazardous according to OSHA 29 CFR 1910.1200.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Do not rub eyes. Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Dusts may irritate the respiratory tract, skin and eyes.
Indication of immediate medical attention and special treatment needed	Treat symptomatically.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO ₂). Apply extinguishing media carefully to avoid creating airborne dust.
Unsuitable extinguishing media	None known.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Use water spray to cool unopened containers. Avoid dust formation.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Wear appropriate protective equipment and clothing during clean-up. Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Avoid the generation of dusts during clean-up. Collect dust using a vacuum cleaner equipped with HEPA filter. This product is miscible in water. Stop the flow of material, if this is without risk. Large Spills: Wet down with water and dike for later disposal. Shovel the material into waste container. Following product recovery, flush area with water. Small Spills: Sweep up or vacuum up spillage and collect in suitable container for disposal. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Minimize dust generation and accumulation. Provide appropriate exhaust ventilation at places where dust is formed. Practice good housekeeping.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store in a well-ventilated place. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
PlumeSTOP® Nutrients (as dust)	PEL	5 mg/m ³	Respirable fraction.
		15 mg/m ³	Total dust.

US. OSHA Table Z-3 (29 CFR 1910.1000)

Components	Type	Value	Form
PlumeSTOP® Nutrients (as dust)	TWA	5 mg/m ³	Respirable fraction.
		15 mg/m ³	Total dust.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
PlumeSTOP® Nutrients (as dust)	TWA	3 mg/m ³	Respirable particles.
		10 mg/m ³	Inhalable particles.

Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Ensure adequate ventilation, especially in confined areas. Local exhaust is suggested for use, where possible, in enclosed or confined spaces.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear safety glasses with side shields (or goggles). Unvented, tight fitting goggles should be worn in dusty areas.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.
Skin protection	
Other	Wear suitable protective clothing.
Respiratory protection	In case of inadequate ventilation, use MSHA/NIOSH approved dust respirator.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.
---------------------------------------	---

9. Physical and chemical properties

Appearance

Physical state	Solid.
Form	Powder.
Color	White.

Odor	Odorless.
-------------	-----------

Odor threshold	Not available.
-----------------------	----------------

pH	Not available.
-----------	----------------

Melting point/freezing point	Not available.
-------------------------------------	----------------

Initial boiling point and boiling range	Not available.
--	----------------

Flash point	Not available.
--------------------	----------------

Evaporation rate	Not available.
-------------------------	----------------

Flammability (solid, gas)	The product is non-combustible.
----------------------------------	---------------------------------

Upper/lower flammability or explosive limits

Flammability limit - lower (%)	Not available.
---------------------------------------	----------------

Flammability limit - upper (%)	Not available.
---------------------------------------	----------------

Explosive limit - lower (%)	Not available.
------------------------------------	----------------

Explosive limit - upper (%)	Not available.
------------------------------------	----------------

Vapor pressure	Not available.
-----------------------	----------------

Vapor density	Not available.
----------------------	----------------

Relative density	Not available.
-------------------------	----------------

Solubility(ies)

Solubility (water)	Completely soluble.
---------------------------	---------------------

Partition coefficient (n-octanol/water)	Not available.
--	----------------

Auto-ignition temperature	Not available.
----------------------------------	----------------

Decomposition temperature	Not available.
----------------------------------	----------------

Viscosity	Not available.
------------------	----------------

Other information

Explosive properties	Not explosive.
-----------------------------	----------------

Oxidizing properties	Not oxidizing.
-----------------------------	----------------

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
-------------------	---

Chemical stability	Material is stable under normal conditions.
---------------------------	---

Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use. Ammonia fumes may be released upon heating.
Conditions to avoid	Contact with incompatible materials. Excessive heat.
Incompatible materials	Strong oxidizing agents. Bases.
Hazardous decomposition products	Ammonia fumes may be released upon heating.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Dust may irritate respiratory system.
Skin contact	Dust or powder may irritate the skin.
Eye contact	Dust may irritate the eyes.
Ingestion	Expected to be a low ingestion hazard.

Symptoms related to the physical, chemical and toxicological characteristics Dusts may irritate the respiratory tract, skin and eyes.

Information on toxicological effects

Acute toxicity	Not expected to be acutely toxic.
Skin corrosion/irritation	Prolonged skin contact may cause temporary irritation.
Serious eye damage/eye irritation	Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

NTP Report on Carcinogens

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not an aspiration hazard.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	No data available.
Mobility in soil	This product is completely water soluble and will disperse in soil.
Other adverse effects	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products

Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging

Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information**DOT**

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable.

15. Regulatory information

US federal regulations This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - No
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical No

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Ammonium sulfate	7783-20-2	40-50

Other federal regulations**Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List**

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations**US. Massachusetts RTK - Substance List**

Ammonium sulfate (CAS 7783-20-2)

US. New Jersey Worker and Community Right-to-Know Act

Not listed.

US. Pennsylvania Worker and Community Right-to-Know Law

Ammonium sulfate (CAS 7783-20-2)

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	No
Canada	Domestic Substances List (DSL)	No
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	No
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	No

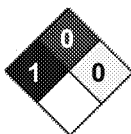
*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).

A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	07-January-2016
Revision date	-
Version #	01
HMIS® ratings	Health: 1 Flammability: 0 Physical hazard: 0


NFPA ratings



Disclaimer

Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

APPENDIX C DVT BORING LOGS

 5 Park Plaza Suite 500, Irvine, CA 92614		Site ID: DVT-1	Date(s): 9/10/2019
		Location: Maurice, Iowa	
Contractor: GeoTek		Logged By: M. Raposo	Checked By:
Drilling Method: B-57		GS Elevation: Not available	TOC Elevation: Not available
Sampling Method: Split Spoon		X Coordinate: Not available	Y Coordinate: Not available
Remarks: Temporary well installed and screened at 42 to 52 (ft) below ground surface (bgs)		Borehole Dia.: 7.25 inches	Total Depth: 54.0 feet
		Project Number: 1690001847	
		Project Name: Vogel	

Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
	1							No Recovery	
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
	11								
	12								
	13								
	14								

Sample Graphics

No Recovery
Fill reflects sample type

Auger Cuttings



Standard Split Spoon



First encountered ground water



5 Park Plaza Suite 500, Irvine, CA 92614

Site ID: DVT-1

Date(s): 9/10/2019

Project Number: 1690001847

Project Name: Vogel

Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								
	26								
	27								
	28								
	29								

**Sample
Graphics**



No Recovery
Fill reflects sample type



Auger Cuttings



Standard Split Spoon



First encountered ground
water



5 Park Plaza Suite 500, Irvine, CA 92614

Site ID: DVT-1

Date(s): 9/10/2019

Project Number: 1690001847

Project Name: Vogel

Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
31									
32									
33									
34									
35				5			CH	CLAY with sand (CH); Dark Gray (5Y 4/1); slightly moist; 90% hard medium plasticity clay, 5% subrounded to rounded gravel up to 0.5", 5% very fine grained to medium grained sand	
36				7	0.0			At 36.0 feet: rounded gravel	
37				10					
38				12	0.0				
39				13					
40				6			CH	CLAY with gravel and sand (CH); Grayish Brown (10YR 5/2); slightly moist; 85% very firm high plasticity clay, 10% very fine grained sand, 5% very fine gravel up to 0.25"; mottled with Strong Brown (7.5YR 4/6) very fine grained sand	
41				10					
42				13	0.0		SP	SAND (SP); Brown (10YR 4/3); saturated; 95% medium grained to coarse grained sand, 5% fines; trace very fine gravel up to 0.5"	▽
43				13	0.0				
44				14					
				7					
				7					
				7					
				7	0.3		SW	SAND with gravel (SW); Grayish Brown (10YR 5/2); saturated; 85% fine grained to very coarse grained sand, predominantly coarse grained, 10% very fine subrounded to angular gravel up to 0.25", 5%	
				15					
<div>Report: RAINBOW WELL LOG WELL ABOVE2; File: BORING LOGS.GPJ; 9/13/19; Library RAMBOLL LOGO LIBRARY.GLB</div> <div><div>Sample Graphics</div><div><div> No Recovery</div><div> Fill reflects sample type</div><div> Auger Cuttings</div><div> Standard Split Spoon</div></div><div><div>▽ First encountered ground water</div></div></div>									



5 Park Plaza Suite 500, Irvine, CA 92614

Site ID: DVT-1

Date(s): 9/10/2019

Project Number: 1690001847

Project Name: Vogel

Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
	46			19			SW-SM	SAND with silt and gravel (SW-SM); Grayish Brown (10YR 5/2); saturated; 80% medium grained to coarse grained sand, 10% fine gravel up to 0.5", 10% fines	
	47			18	0.1				
	48			15					
	49			20			SP	SAND (SP); Brown (10YR 4/3); saturated; 85% fine grained to medium grained sand, predominantly fine grained, 10% silt, 5% very fine gravel; micaceous	
	50			10					
	51			12	0.1		SW-SM	SAND with silt and gravel (SW-SM); Grayish Brown (10YR 5/2); saturated; 80% medium grained to coarse grained sand, 10% fine gravel up to 0.5", 10% fines	
	52			8					
	53			4					
	54			32					
	55			21	0.2		CH	CLAY with sand (CH); Strong Brown (7.5YR 5/6); dry to slightly moist; 85% hard clay, 15% fine grained to medium grained sand, 5% rounded fine gravel	
	56			22					
	57			31					
	58			29					
	59			18					
	60			21					
	61			22					
	62			16					
	63			15					
	64							Boring completed to a depth of 54.0 feet on 9/10/2019	

Sample
Graphics



No Recovery
Fill reflects sample type




Auger Cuttings



Standard Split Spoon



First encountered ground
water

 5 Park Plaza Suite 500, Irvine, CA 92614		Site ID: DVT-2	Date(s): 9/10/2019
		Location: Maurice, Iowa	
Contractor: GeoTek		Logged By: M. Raposo	Checked By:
Drilling Method: B-57		GS Elevation: Not available	TOC Elevation: Not available
Sampling Method: Split Spoon		X Coordinate: Not available	Y Coordinate: Not available
Remarks: Temporary well installed and screened at 42 to 52 (ft) below ground surface (bgs)		Borehole Dia.: 7.25 inches	Total Depth: 56.5 feet
		Project Number: 1690001847	
		Project Name: Vogel	

Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
	1							No Recovery	
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
	11								
	12								
	13								
	14								

Sample Graphics

No Recovery
Fill reflects sample type

Auger Cuttings



Standard Split Spoon



First encountered ground water



5 Park Plaza Suite 500, Irvine, CA 92614

Site ID: DVT-2


Date(s): 9/10/2019


Project Number: 1690001847


Project Name: Vogel


Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								
	26								
	27								
	28								
	29								

**Sample
Graphics**

 No Recovery
Fill reflects sample type

 Auger Cuttings

 Standard Split Spoon

 First encountered ground
water



5 Park Plaza Suite 500, Irvine, CA 92614

Site ID: DVT-2

Date(s): 9/10/2019

Project Number: 1690001847

Project Name: Vogel

Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
31									
32									
33									
34									
35				5			CH	CLAY with sand (CH); Dark Gray (5Y 4/1); slightly moist; 90% very firm clay, 5% scattered very fine grained to coarse grained, 5% subrounded to rounded very fine gravel up to 0.5"	
36				6					
				10					
37				12	0.0				
				15					
38				5	0.3		SP-SM	SAND with silt (SP-SM) lense; Dark Yellowish Brown (10YR 4/4); slightly moist to moist; 90% very fine grained to medium grained sand, 10% clayey silt	
				7			CH	CLAY with sand (CH); Dark Gray (5Y 4/1); slightly moist; 90% very firm clay, 5% scattered very fine grained to coarse grained, 5% subrounded to rounded very fine gravel up to 0.5"	
39				9					
				10					
40				12					
				14					
41				13	1.3			From 41.0 feet: color becomes Brown (10YR 4/2), slightly moist From 41.0 to 41.25 feet: iron oxide with sand lense	
				14					
42				15				From 42.0 to 44.5 feet: no recovery - rock fragments	▽
				32					
43				18					
				22					
44				27					
				27					
				19			SW-SM	SAND with gravel (SW-SM); Yellowish Brown (10YR 5/4); saturated;	
<div>Report: RAINBOW WELL LOG WELL ABOVE2; File: BORING LOGS.GPJ; 9/13/19; Library RAMBOLL LOGO LIBRARY.GLB</div> <div><div>Sample Graphics</div><div><div> No Recovery</div><div> Fill reflects sample type</div><div> Auger Cuttings</div><div> Standard Split Spoon</div></div><div><div>▽ First encountered ground water</div></div></div>									
Page 3 of 4									



5 Park Plaza Suite 500, Irvine, CA 92614

Site ID: DVT-2

Date(s): 9/10/2019

Project Number: 1690001847

Project Name: Vogel

Elevation (ft)	Depth (ft)	Sample Interval	Sample No.	Blow Count	PID (ppm)	Graphic Log	Material Code	Material Description	Water Level
	46			19			SW-SM	85% medium grained to coarse grained sand, 10% fine to medium gravel up to 1.25", 5% fines	
				24	10.3				
				22					
	47			11			MH	SANDY SILT (MH); Gray (10YR 5/1); saturated; 60% low plasticity fines, 45% very fine grained sand	
				8				From 46.7 to 47.0 feet: thin Very Dark Gray band	
				10					
	48			14	21.7		SW	SAND with gravel (SW); Yellowish Brown (10YR 5/4); saturated; 85% medium grained to coarse grained sand, 10% fine to medium gravel up to 1.25", 5% fines; slight petroleum odor observed	
				10					
	49			10					
				17					
	50			27	1.5				
				29	37.5				
				20				From 50.5 to 51.5 feet: decreased sand content to 70%, medium grained to coarse grained sand, medium to large subangular gravel up to 1.5", predominantly 0.5 to 1",	
	51			25				From 51.5 feet: sand is predominantly coarse grained to very coarse grained	
				25					
	52			21					
				17	0.3		CH	CLAY with sand (CH); Strong Brown (5YR 4/4) mottled with Grayish Brown (10YR 4/2); dry to slightly moist; 70% very firm clay, 30% very fine grained sand	
				20				From 53.0 to 53.5 feet: very abundant iron oxide staining	
	53			9					
				14				From 54.5 feet: color becomes Dark Gray (10YR 5/1), dry to slightly moist	
	54			19	0.1				
				23					
	55			31	0.0				
	56							Boring completed to a depth of 56.5 feet on 9/10/2019	

Sample Graphics



No Recovery
Fill reflects sample type



Auger Cuttings



Standard Split Spoon



First encountered ground water